THE PAPER TRADE

A·DYKES SPICER

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THE PAPER TRADE

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PAPER TRADE

A DESCRIPTIVE AND HISTORICAL SURVEY OF THE PAPER TRADE FROM THE COMMENCEMENT OF THE NINETEENTH CENTURY .

BY

A. DYKES SPICER M.A.

WITH DIAGRAMS AND PLANS

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THIS BOOK

IS DEDICATED TO

MY FATHER, UNCLES, AND COUSINS,

COMPOSING THE

FIRM OF

JAMES SPICER AND SONS

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PREFACE

THE importance of estimating what is being done in the various industries of this country was recognised not long ago in a pronouncement made by the President of the Board of Trade. The idea of the present work was suggested to me long before by the late Director of the London School of Economics, who inspired me to undertake the detailed study of the trade, in a branch of which I was personally engaged. This, I was persuaded, would be a labour of certain value to myself, and my hopes in this respect have been amply realised. But I had the further ambition that a book embodying my researches might be not without value both to those who, like myself, are personally connected with the Paper Trade, and perhaps also to others who have a general interest in the industrial conditions of this country. At least I have been able to amass a body of information which has not before been brought together in a single work; and it remains to be seen whether from this, and from the statistics available in official papers, I have been able to trace those main features of the trade which should go to the making of a description and a history.

The promise made by the President of the Board of Trade, that definite steps should be taken to ascertain the productive capacity of this country in its various industries was particularly welcome to me, for one of the greatest difficulties with which I have been confronted has been to discover, or rather I should say to estimate, the quantity of paper made in Great Britain since the Excise Duty was removed.

To the general readers it may seem that the accounts of processes of manufacture are too technical; to those engaged in the trade that they are not technical enough. All I can say is, that I have attempted to hold the balance between these two extremes, and while avoiding minute details of technical description on the one hand, on the other I have thought it would be useless to make my account so "general" as to omit what it is the purpose of my work to describe. Being myself connected with a distributing, and not a manufacturing (except with paper as the raw material), house of business, I have naturally viewed the processes of manufacture from an outside standpoint.

My task would have been impossible but for the kind help I have received from numberless persons engaged in the paper industry, and many others. I must not conclude without acknowledging the assistance rendered to me by Mr. Clayton Beadle and Dr. Stevens, who have obtained for me a vast amount of information, particularly from the technical aspect of the work; Mr. T. Y. Nuttall, who has given me the benefit of his opinion upon many of my statements regarding the manufacture of paper; the editor of the *World's Paper Trade Review* for so kindly allowing me to make use of his many informing articles on the History of Papermaking, &c.; Mr. Hepburn and Mr. Horsburgh, of the Hele Paper Company, for allowing me to spend two days at their mill, and during that time to go where I pleased, and ask any questions as they occurred to me.

Valuable information with reference to *rags* was also given me by Mr. R. Hough and Mr. Russell, of Messrs. Tullis & Co. *Esparto* by Mr. J. Christie; Mr. Murison, Vice-Consul of Almeria; and Mr. Barber, Vice-Consul of Oran. *Machinery*—Mr. James Nuttall, of Messrs. Bentley & Jackson; Mr. T. M. Lumsden, of Messrs. J. Milne & Sons; Mr. J. Youle, of Clondalkin; Messrs. Bertrams, Limited; and Mr. H. J. Donkin, descendant of Bryan Donkin. *Chemicals*—Messrs. S. W. Royse & Co. *Trade Unions and Rates of Wages*—Mr. C. Howard, Treasurer, and Mr. Dyson, Secretary of Amalgamated Society of Papermakers; Mr. Ross, Secretary of National Union of Papermaker Workers; Mr. Bourne, Secretary of Original Society of Papermakers. With Mr. Howard and Mr. Bourne I had several interesting conversations at their homes, and am greatly indebted to them for the insight they so willingly gave me into their respective societies.

In my attempt at estimating the amount of capital launched in the Paper Trade, I was greatly assisted by Mr. A. W. Masson, an expert valuer and paper-making engineer; and finally to the Secretary of the Papermakers' Association and to all the various gentlemen throughout Great Britain and Ireland who so kindly gave me brief histories of their mills, I am peculiarly grateful.

A. D. S.

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THE PAPER TRADE

CHAPTER I

INTRODUCTORY

If the manufacture of paper were proportional to the importance of paper in modern life, it would be the largest industry in Great Britain. Paper is the cheapest and most familiar object in every English household. Every one knows how to read, and books and newspapers have come to be within the reach of the poorest. The first material which must be at the disposal of every clerk in the country is the paper which goes to the making of ledgers and notebooks. Hundreds of millions of letters go through the post every year. Almost every article bought at a shop is wrapped up in paper. In a most literal sense we may say that all other manufactures in this or any other country have come to be dependent upon the manufacture of paper; it is an indispensable ingredient in every industrial and commercial process.

The growth of the paper industry and the cheapening in price has had a more profound effect upon the community than the invention of the steam engine. Without cheap paper, penny and halfpenny newspapers could never have come into being, and the power of the Press would have been limited accordingly. Without cheap paper, books could not be issued at low prices, and popular education would lose its effect. Everywhere the use and influence of this potent article of commerce has been one of the leading characteristics of the nineteenth century.

And yet we may say of paper what is true of many other valuable things—a little goes a long way. Hence its manufacture has never bulked large in our trade like that of cotton or wool or hardware—it has never been a primary factor in industrial history. Yet, though from the point of view of production, it is a trade of secondary importance to the consumer, its use bulks so large that an account of it may, perhaps, be more interesting than an account of any other commodity.

The history of the trade, for the purpose of this book, begins in the second half of the eighteenth century. Up to that period, almost from time immemorial, paper had been produced in much the same way by simple hand processes. But then came a short epoch of mechanical improvements, which will be described in a later chapter, followed by a fresh outburst of activity with the introduction of steam. The more economical methods of manufacture, and the larger output meeting a larger demand, led to the quest for new raw material and new markets. We shall, then, have to consider changes in machinery and changing processes of manufacture, the opening up of fresh supplies of raw material from foreign countries, which will further lead us to questions of taxation, quantities, and price. Moreover, we shall find the history of the paper trade, like that of many other trades, affected by the new conditions of labour which have been brought about by trade combinations and the growth of the democratic spirit. But these influences will be less obvious than usual, for the introduction of machinery did not at once create a large demand for new labour, and the traditions which had formerly prevailed among the skilled workers in the hand-mills were to some extent, though of course only to some extent, passed on to their successors in the machine factories. Further questions which will come up for discussion in this work are the localisation of the industry, and the means by which the finished paper passes from the maker to the consumer.

The number of mills[1] in the British Isles has by no means varied in proportion to the amount of paper made within their walls. England has always had far more mills than Scotland and Ireland, and in the times when paper was entirely, or principally, made by hand, she possessed almost the entire number that were to be found in these islands. At the opening of the nineteenth century the aggregate appears to have been about 500. In 1836 the total must have reached 525 or thereabouts, for at that date a fair number are to be found in existence in Scotland and Ireland, while England still possessed about 400, the number in the Southern Kingdom having declined somewhat owing to the introduction of machinery.

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[1] See Appendix V.

The Scottish aggregate has remained fairly stationary for many years, for in 1840 it stood at 50 and to-day it amounts to 60. Ireland, on the other hand, shows a great decrease during the same period. In 1840 she possessed 60 mills, whereas to-day she possesses only 9. A steady diminution took place throughout the period from 1840 to 1860. Since the later date the number has fluctuated. The number of mills in England has also decreased since 1840, until to-day it stands at only 211. Thus, for the last 60 years the United Kingdom, as a whole, shows a general decline in the number of its mills. In 1860 it possessed 400; at the present time it has only 279.

This diminution in the number of paper manufactories is to be attributed to several causes. First and foremost amongst these stand the extension and use of machinery in paper-making, and the continual introduction of improvements in the machinery so employed. At the beginning of the nineteenth century, practically little or no machinery was in use in the trade. The application of steam and water power vastly increased the output, and in conjunction with the building of railways and the improvements effected in the means of communication, confined production to fewer localities. The amount that could be extracted from the vat or hand-made mill was strictly limited, but the output of machines, especially the improved machines of recent times, is practically unlimited.

Further small mills have dropped out owing to the overwhelming competition of larger establishments run on capitalistic lines. Where a greater output is made possible, the fixed charges are proportionately reduced, greater economy in production is effected and low prices are attained with which the smaller mills cannot compete. Only those could continue business who either manufactured on the large scale or else offered a peculiar or exceptional quality of paper which practically amounted to a monopoly.

Many mills, too, have disappeared owing to their isolated situation. They were placed in remote river valleys which have been untouched by railways and modern means of communication, so that, stranded in an industrial backwater, they were unable to survive in the struggle with their more happily situated rivals. Such works have practically died out and there is to-day little or no trace of them to be found.

In the nature of things the owner of a small vat mill was bound to be defeated by a manufacturer who possessed a machine factory, even though merely of the same size. The former was often at the mercy of his workers, who belonged to a Club or Union, and so could at times dictate to their master and, being skilled artisans, were difficult to replace. The latter, on the other hand, was far more independent of his workmen. His method of production was by machinery which did not demand such specialised skill as when paper was manufactured by hand, but only required ordinary intelligence and careful supervision. It was thus comparatively easy for him to obtain a fresh supply of labour.

The modern paper mill is a vastly more complicated establishment than the mill of a century ago. The latter was constructed on a definite and distinct plan, but on lines entirely different from those followed at the present time. A hundred years back rags formed the raw material for papermaking, and these could not be purchased in a really reliable and assorted state. They had, therefore, to be overhauled in a store close to the mill, and the qualities laid aside in different bins. This work was generally done by women. The rags thus assorted were passed out to other workers in this department of the mill, who cut them. They were then dusted and left to rot as no method of boiling had yet been devised. When they had become sufficiently rotten, the stamper would in early times reduce them to pulp. Later on, however, this pulping process was effected by a machine invented for the purpose, known as the Hollander, inside which the rags were placed and broken into a semi-pulped condition. It is probably true that at the commencement of the nineteenth century there were in many mills both stampers and breakers.

The rag pulp was next subjected to the bleaching process. Before the discovery of chlorine there was no chemical bleaching. The rag-pulp was moistened and spread out on the grass, exposed to the sun, and occasionally moistened again until the requisite colour was obtained.

After this the pulp was beaten into a fine consistency and made into paper by what is termed the "hand" process—a method which will be fully described at a later period in the book.

The mill, especially if situated in an out-of-the-way place, would have to be provided with a wheelwright's shop and forge. As a rule the proprietor or manager lived in a house adjoining the works. A few manufactories consisted of one compact building, but with the majority the different departments were in different buildings, and that is still the case with many of the older establishments existing to-day.

When a new mill is laid down, it is of course constructed on different principles from one that has gradually grown, or been altered to meet modern requirements. The construction of the modern mill may be seen from the accompanying plan.

The particular mill depicted is one for working rag papers, but an esparto or wood-pulp factory would be, with the exception of one or two details, similarly arranged. The plan shows the room for storing the raw material (1), and the house where the rags are cut and dusted (2). Chemicals are kept in an adjoining chamber (3), and below are tanks where the bleach is mixed (4). An elevator (5) takes the cut and dusted rags to the mouths of the boilers (6). Into these they are let down; all resinous matter is extracted from them, only the pure cellulose remaining, and the first important stage of the paper-making is performed. From the boilers the rags are removed and put into breakers where bleach is added, and where they are thoroughly washed. After draining in the bleach-house, the half-stuff is taken to beaters (7) and the pulp, after the fibres have again been thoroughly cleared and opened in a refining engine,[1] (8) is passed in to stuff chests (9) instead of vats; and thence it is pumped into the paper machine.

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[1] The most famous refining engine is the Marshall, so called after its inventor. It is intended to split and open the fibres and thus give an even look through, instead of leaving them long and thick and so causing a cloudy appearance in the paper.

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CHAPTER II

THE PULPING OF RAW MATERIAL

DURING the first half of the nineteenth century rags formed the staple raw material of the paper-making trade; but at the present time, though they represent much of what is best in English paper, other materials, such as esparto and wood-pulp, are more largely used.

To consider first the rags which form part of the material now in use, chief among which are superfines,[1] outshots,[2] seconds,[3] thirds,[4] and prints.[5] These are domestic products gathered, to a large extent, by hawkers and small rag merchants. These people, after they have been their rounds, go to the wholesale rag merchants, obtaining in exchange money where formerly they obtained china. The buyers sort over and grade the rags, and put them through a process of disinfecting, which is made compulsory for foreign rags. Other kinds of rag now in use—new cuttings,[1] gunny,[2] blues,[3] and rope[4]—are collected by the wholesale merchants from the producers, principally at industrial or shipping centres, and are then graded before being sent to the paper-mills.

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[1] *Superfines and fines*, quite old white rags, practically all cotton from shirts, sheets, &c.

[2] *Outshots*, less clean and off colour, while *firsts* are the very cleanest and best.

[3] *Seconds*, clean, slightly coloured rags as above.

[4] *Thirds*, darker and dirtier ones.

[5] *Prints*, mostly used for blotting-papers, and are coloured and soft.

Formerly the paper-mills bought rags of all qualities in what would now be considered mixed lots, and did the grading for themselves; but of late years they have had to specialise and use only one grade, with the result that the rag merchant has gradually come to do the sorting for himself, selling to paper-makers the quality which suits them best. Consequently the latter keep a comparatively small staff of rag-sorters, who figure largely in the establishments of the collecting merchants.[5]

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[1] *New cuttings*, which comprise linen pieces, cotton pieces, new prints, all come from shirtings, underlinen, coat linings, shoes and boot linings, fustian garments, ties, blouses, bleachers and sails, military and naval linen and cotton garments, and, in fact, from all places where cotton, linen, &c., are used.

[2] *Gunny*, any old bagging or wrappings from cases, bales, &c. (chiefly used for brown papers).

[3] *Blues*, rags from blouses from abroad, or anything of blue colour.

[4] *Rope*, manilla rope from ships and railways, used mostly in U.S.A.

[5] "The sorting of rags is a most important department, for, unless the rags which are beaten all together in the engine are all of the same quality, both as to substance and condition, the finest and best parts will be ground away in the mill and be carried off

On reaching the paper-mills, the rags stowed in sacks and bales are discharged on to the floor of the store-room ; thence they are fed into a duster consisting of a long revolving drum placed horizontally inside a box with open ends, about 30 inches in length by 5 feet in diameter. This drum is covered with coarse wire gauze, and the inside is provided with a series of prongs and a revolving helical screw, which causes the rags to travel from one end of the drum to the other, while the prongs at the same time keep them well stirred. Thus they move round, allowing the loose dirt to pass through the meshes of the wire, and after being well dusted are taken by the sorters or pickers on to a hurdle or table covered with wire gauze. The hurdle is provided with a sharp knife of about 12 inches long, placed at an angle sloping towards the worker, who takes bunches of the rags and draws them across the knife, cutting them into pieces of about 4 inches square, and at

by the water before the coarser are sufficiently reduced to make a fine pulp. For this reason, in the sorting of rags for fine paper, the hems and seams should be kept apart, and the coarseness of the cloth should be considered. That cloth which is made of tow should be separated from that which is made of longer fibres, cloth of hemp from cloth of flax, and lastly, the degree of weaving in the cloth should be noticed. For if rags almost new are mixed with those much worn, the one will not be completely reduced to a pulp, while the other will be so beaten as to be carried off by the water. The result must be a considerable waste in the operation, and a real loss to the manufacturer. The look and also the strength of paper depends largely on the sorting, which cannot be too carefully performed" (*vide* Dr. Arnot on "Paper-making").

the same time sorting them into different qualities. Small, upright, rectangular wooden bins are placed on the side of the hurdle, and the different grades of rag are thrown each into the proper bin. For the best papers, rags are hand cut; for lower qualities they are cut by machinery—the process being that they are fed by means of a travelling band on to a machine provided with a rotating knife which cuts them into pieces about 3 inches in length.

In order to remove all dust and dirt thoroughly, sorted and cut rags are passed through a rag "devil," which consists of two cylinders rotating in opposite directions and each containing numerous prongs. The rags are quickly agitated, and, passing from one end to the other, are discharged into a second revolving duster, through which the loosened dirt falls. They are then fed into the revolving steam boilers, and trodden in as tightly as possible.

> "The work," according to Arnot, "is the extraction of fatty, glutinous, and colouring matters; with some of these substances, it combines to form soaps; some it decomposes, and others are dissolved by its agency. It has also a softening action on the fabric of the rags, which renders the disintegration of them in the after processes more easy of accomplishment."

The material being now in the boilers, caustic soda liquor is added from 1 per cent. up to 6 per cent. on the weight boiled. Fifteen to twenty pounds is the customary pressure, and the time of boiling varies between two and twelve hours. The pressure is maintained by live steam, the liquor is blown off, and the rags are washed by passing water through the boiler. They are now ready to be carried in a perforated pan to a breaking engine, and then broken up till they are in the condition in which they become known as "half-stuff." The process is completed by passing fresh water into the engine and carrying it away when dirty through another revolving drum, and bleaching the damp material by adding, in the form of a solution, chloride of lime.[1] The "half-stuff" is now discharged into sleeping tanks.

This brief outline has presented the processes by which rags are converted into the partially prepared material from which paper is made. But rags alone could never have been procured in sufficient quantities to satisfy the needs of the English manufacturer. Their scarcity by 1860 was proverbial. It became necessary to find some new material to supplement them, and take their place; and all the more so in view of the fact that after 1861 home manufacturers were confronted with the competition of foreign makers who under free trade conditions began to import paper on a larger scale into the country.

Two conditions were essential to the successful introduction of a substitute: (1) That the substance should be both cheap and procurable in abundance; (2) that it should become cleansed and bleach rapidly, and yield a strong, pliable fibre which would produce paper possessed of permanent whiteness and free from knots. For some time many experiments were made without success. Nothing satisfactory was found to tide the paper-makers over the troublous years of 1860, 1861, and 1862. It was the discovery of the uses of esparto grass which brought the crisis to an end. No sooner was it introduced into this country and put to practical purpose, than it was found to supply the impetus necessary to revive the English paper trade, and enable it to face foreign competition on more equal terms.

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[1] One to 6 per cent. on the weight of the dry material.

This grass grows wild in root-clusters from 2 to 10 feet in circumference, on rocky and dry mountainous districts within the area known as the Esparto Zone (32° to 41° north latitude, including the southern part of Spain and the northern border of Africa). The young seedling is very delicate and easily killed by late frosts. For the first two years the early growth is scarcely perceptible, but after twelve or fifteen years the plant reaches its full development. It abounds at all elevations from sea-level to a height about 3,000 feet. It is generally fully grown in July, especially in the most sunny localities, and is then ready to be gathered.

The operation of harvesting is not performed by mowing but by pulling, and this is accomplished by various methods. One is by means of a short, drum-shaped piece of wood, named "arancadera." This hangs suspended by the handle from the harvester's shoulder, waist, or wrist. With his right hand he lays hold of the tops of the esparto, twisting them round the pointed end of the drumstick, and with a sudden upward and sideward pull the esparto leaves are torn from the stem and deposited in the left hand. A second method is the use of a flat piece of leather, hung by a short cord from the wrist and manipulated in the same way as the drumstick. A third is by the hand only, protected from injury by a leather covering; as soon as the left hand has covered as much as it can grasp between the index finger and thumb, the bundle is secured by a turning of its own leaves, and laid on the ground to dry. Every two of these bundles make up what is known as a "menada;" ten or twelve "menadas" make a "pace," and every three of these make a "caya," or donkey load. The "caya" is the standard measure, and when dry weighs about 2 lbs.

Dried like hay, sorted into different qualities, and baled up under pressure with iron bands, but without external covering, the grass is ready to be transported to the mill, where it is opened up and passed through dusters and along travelling bands. The root ends and other impurities are picked out by hand. It is then stacked into vomiting boilers and treated with caustic soda[1] under pressure. The pressure does not usually exceed 20 lbs., and from 2½ to 3 hours is sufficient for the boiling. This removes the incrusting and silicious matter, and reduces the bundle of grass to pulp, which is then blown from the digesters into receptacles where the liquor is separated by careful washing, and bleached in chloride of lime solution by a continuous process, whereby the liquor is used over and over again.[1]

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[1] About 18 lbs. of caustic soda of 60 per cent. strength is required when used in conjunction with the Spanish or best quality grass, while with the Tripoli plant about 20–21 lbs.

Since Mr. Routledge, in 1861, patented his process for treating esparto, it has been the peculiar raw material used by England for her papermaking. Plant was erected, and, owing to cheap freights, it was possible to introduce esparto at a low rate. But the real cause that this country alone has made use of esparto is the fact that England is the home of the chemical industries, and esparto, requiring a very large amount of chemicals, could easily be turned into pulp where this material was cheap. It is turned into "half-stuff" on the premises of the mill, as the treatment requires special plant and experience. Enough esparto mills exist in this country to take the whole of the world's output. The paper thus made has a peculiar character of its own, and the English public has become accustomed to its use.

By 1880 the import of esparto had reached 200,000 tons; rags were imported to the extent of 30,000 tons; the home supply had remained about the same for some considerable period; yet in spite of these enormously increased supplies the demand for paper-making material was in no way satisfactorily met. The inventors were still confronted with the problem of finding some substance to supply the mills.

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[1] This method of recovery was introduced about 1877, and enables an economy to be practised of some 15 per cent. in the use of soda. Sometimes the bleach is used in pitchers, at others in steep or patent circulating tanks, and an air-dry original grass is considered to yield from 42 to 45 pe1 cent. of paper.

A raw material, which had always appeared to possess great possibilities, was wood. As early as 1800, when Koops published his book on paper, the use of wood-pulp was discussed; but at that period it could not be made to compete successfully against rags. It was difficult to obtain anything of more than ephemeral value. We hear that it was introduced into this country about 1871, but this could only have been the mechanical pulp discovered by a watchmaker, Keller. Of historical interest but without possessing any practical importance, is the fact that in 1854 R. and T. C. Martin secured the patent in this country for obtaining pulp from wood. The wood which was to be used for paper-making originally came from Sweden and Norway, but of late Canada has made great strides in competition with those two countries. The trees are felled in the early part of the winter by gangs of men, under the superintendence of experienced timber experts, and in the course of a day each small gang of three men can cut down fifty or sixty trees, remove all branches, and saw up the trunk into lengths of 12 feet, 14 feet, and 16 feet. The logs stacked in the forest at various spots are then dragged on to the frozen surface of rivers and piled on the ice. In the early spring the ice melts, and the stream floats the logs to the pulp-mills.

Their destination reached, they are hauled out on the shore, and in the summer months they are carried by means of an endless chain into the "barker." An ingenious arrangement of travelling belts and conveyors keeps the supply constant. The logs are cut up into lengths of 2 feet with powerful circular saws, and the complete removal of the outer bark accomplished by a machine, which consists of a heavy cast-iron disc fitted with sharp steel blades projecting from the surface. Seizing hold of the piece of wood by the two ends, the workman presses the side of the short log against the rapidly rotating disc, at the same time revolving the piece of wood. The clean piece is automatically taken away for further operations, while the bark and refuse is blown down a shute and subsequently used as fuel for the steam boilers. Thus all the waste wood is profitably utilised, and the loss due to the removal of the bark, often amounting to 25 per cent., is turned to good account.

Two qualities of pulp are obtained from these logs—mechanical and chemical. The former is produced by forcing logs of pine-wood by hydraulic pressure against the surface of a rapidly revolving sandstone, which gradually disintegrates the fibre, and so is called mechanical pulp. It was the first form in which wood was used for paper-making, and while still retaining its supremacy for ephemeral purposes has little felting power, and can only produce by itself a weak paper with no lasting qualities. It requires[1] 80 h.p. to make one short dry ton (about 2,000 lbs.) per day, or, say, 90 h.p. to make one long dry ton (2,240 lbs.), so that a mill developing 1,800 h.p. on the turbines should produce 20 tons of dry mechanical pulp per day or 6,000 tons per year of 300 working days.

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[1] On the subject of the actual cost of producing mechanical pulp a fairly reliable estimate is approximately the following (given by Mr. Nordberg, of Alsing and Co.):—

Cutting and carting down timber from wood	10s. per ton.
Floating in river	4s. ,, ,,
To make the timber from the storage place into wood-pulp	13s. ,, ,,

In the different producing districts the range of costs is as follows for—

WET PULP.

East Norway	25s. to 30s. per ton.
North Sweden	22s. to 25s. ,, ,,
Canada's Lake, St. John, and portions of Nova Scotia	13s. 6d. to 15s. per ton.
St. Maurice River and other districts	15s. to 22s. per ton.

DRY PULP.

The net cost, allowing for depreciation, is given approximately as follows—

	Per Ton Dry Weight.
Modern mills in Norway, C/A	£3 0 0
Modern mills in Sweden, C/A	£2 15 0
Lake St. John	£1 17 6
St. Maurice district	£2 10 0

(S. C. Phillips's lecture to Society of Arts, May 17th, on "Wood-pulp for Paper-making.")

For mechanical pulp, poplar, aspen, spruce, and fir are mostly used, and, although almost every class of wood can be converted into pulp, only the soft coniferous trees are economically suitable. Trees having a diameter of from 6 to 20 inches at the base, and of about twenty years' growth are considered best. Smaller logs are not so economically worked, and larger timber is usually cut for lumber.

Within the last few years a great number of pulp-mills have been started in the Eastern and Western States of America and other parts of the world, which, in order to utilise the particular class of wood growing in those districts, have adopted somewhat special methods, and wood-pulp is now produced from a great variety of woods.

But it was the wood treated by chemical means which started the new era in paper manufacture. The class of wood generally used for the manufacture of chemical pulp is known as soft wood, and belongs to the order coniferæ, or cone-bearing trees. The common spruce and the silver fir are the chief species that supply the chemical pulp of Europe, while the white spruce, black spruce, Canadian hemlock, white American pine, and the silver fir provide the bulk of wood-pulp in America.

Three methods have been discovered—the sulphite, the sulphate, and the soda-pulp. The sulphite process is obtained by treating chips of wood under a pressure of about 7 atmospheres with a solution of bisulphite of lime, or magnesia, for a period of from eight hours to three days, according to the method adopted and the kind of pulp required. The other methods—the sulphate and soda-pulp—are almost identical. Chips of wood are boiled in a three to one solution of sodium sulphate. The pulp thus produced is discharged from the boilers into tanks where it is washed, and then passed into screens for removing the chips and uncooked pieces. Thence it goes into a machine by which a large percentage of water is removed, so that the pulp now, in the form of wet sheets, is ready for use. Owing to the fact that there is a greater recovery from the waste products, the sulphate process is the most economical, and it has therefore been coming more into vogue every year. Sometimes wood-pulp is shipped containing 50 per cent. of surplus moisture and sometimes in its air-dry condition.[1] In the former case it has to be passed over steam drying cylinders to absorb the moisture before boiling.

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[1] The air-dry pulp contains 10 per cent. of moisture, and the wet pulp 50 per cent. of surplus moisture and 50 per cent. of air-dry pulp. By a simple deduction the wet pulp containing 50 per cent. of surplus moisture possesses actually 45 per cent. of bone-dry fibre (*i.e.*, when the pulp has been put into an oven and the natural or atmospheric moisture absorbed), 5 per cent. air-dry moisture, and 50 per cent. surplus moisture, and on these bases the pulp is invoiced and consigned to the country for which it is destined. A hundred tons of sulphite pulp in air-dry condition will produce 47 tons of paper, the same quantity of sulphate pulp in the same state will give 53 tons of paper, and 100 tons of air-dry mechanical pulp will yield 87 tons of paper, but of a much poorer quality than that got from chemical pulp.

The first patent for beating wood by chemical methods, and thus obtaining a more lasting and durable paper from wood pulp, was taken out by B. G. Tilghman, a chemist of Philadelphia, in 1867. His original specification practically covers the various methods employed by subsequent inventors, and he is described by some authorities, notably American, as the father of the sulphite process. It is probable that Tilghman in his specification anticipated all subsequent patents,[1] although he did not bring them to a state of perfection in practical working.

He started by boiling in lead-lined cylinders; but although an excellent fibre was obtained, the engineering difficulties rendered it necessary to abandon the process. Ekman, the Swedish chemist, appears to have been the first to make the sulphite process successful. He set to work in 1872, using a solution of bi-sulphite of magnesia. His process was worked secretly until about 1879, when it was introduced in the Ilford Mills, near London. In 1884 the proprietors of the patent erected large mills at Northfleet, where the process was conducted by the Ekman Pulp and Paper Company, but was finally abandoned in 1903–4 through the impossibility of competing with foreign combines as regards the cost of timber. The great difficulty in the way of making the sulphite process a success was due to the corrosive action of the liquor. This quickly eats through iron and has a certain amount of action upon lead. Many linings were substituted, among them cement, but the trouble was finally overcome by introducing a special kind of brick lining.

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[1] See Griffin and Little, "The Chemistry of Papermaking."

The Partington process, acquired by the American Sulphite Company about 1884, was the first to be made use of in the U.S.A. It was also conducted in this country for some time by the Kellner-Partington Company.

Another inventor, Mitscherlich, Professor of Chemistry at Munden, began experimenting with the sulphite process about 1876. Later on he went to Thode Mill, near Dresden, and started his experiments as a commercial undertaking in 1881. Many lawsuits were fought for the rival patents, which showed close resemblance to one another in their claims.

Behrend, in 1883, disputed the validity of the Mitscherlich patents, on the grounds of the priority of Tilghman's British patents, and the German Board concluded that the former process did not sufficiently differ from the latter to entitle it to protection.

So far, the problem of saving the waste products in the case of the sulphite method has not been solved to the extent it has been in the case of the soda and sulphate methods, and its further success in the future may largely depend on the discovery of a means of effecting economies. The waste liquor is of straw colour, and cannot be recovered, but the sulphurous acid gas from the digester or boiler can be largely used again for dissolving fresh limestones. This does not mean that no economies have been effected. Ekman invented a process for precipitating the organic matter, by which a valuable product known as "dextrone" was obtained, and is used for paper sizing and sticking purposes and weighting jute bags. Partington also claims to have made valuable use of liquor for laying dust on roads.

In the soda process, the chemical, being an expensive material, has to be recovered, and of what is used only about 15 per cent. is lost. This has to be made good by the addition either of caustic soda or carbonate of soda. Cheapest of all is the sulphate process, as the lost soda can be substituted by a less expensive chemical-sulphate of soda.

CHAPTER III

THE SOURCES OF SUPPLY

SO far we have been examining the process by which the raw material—rags, esparto, and wood-pulp—is converted into the condition of half-stuff. At this point it may be convenient to pause and consider some of the difficulties which have governed the choice of markets. In this inquiry we have to take into account historical facts which have regulated the importation of material from abroad, and the price of that material. Facts which are familiar in the history of industry as a whole we shall find exemplified in the case of this particular industry—the influence, for example, of the Napoleonic wars, the introduction of machinery, and the greater value which has come to be attached to labour.

Previous to the Napoleonic war England was dependent on material derived, in a fairly equal proportion, from home and foreign sources. But in 1808, when Napoleon was at the height of his power, there was a considerable fall in the importation of rags from Germany and Italy, the principal countries who exported them. At the conclusion of the war, and at the general reopening of Continental markets, foreign rags came in large quantities for paper-making purposes.[1] This importation was encouraged by the English Government; for while in 1803 she had imposed a tax of 15s. 9d. per ton, and six years later of 22s. 3d., in 1824 she reduced it to 5s., and the net loss to the revenue amounted to £9,893. The average importation between 1780 and 1820 had been 9,000 to 10,000 tons, and the introduction of machinery and an increased demand for raw material had induced the country to lower the duty. But soon after, the impetus given to the importation of rags was checked by France, Belgium, Holland, Spain, and Portugal, all of them prohibiting the exportation of rags, and

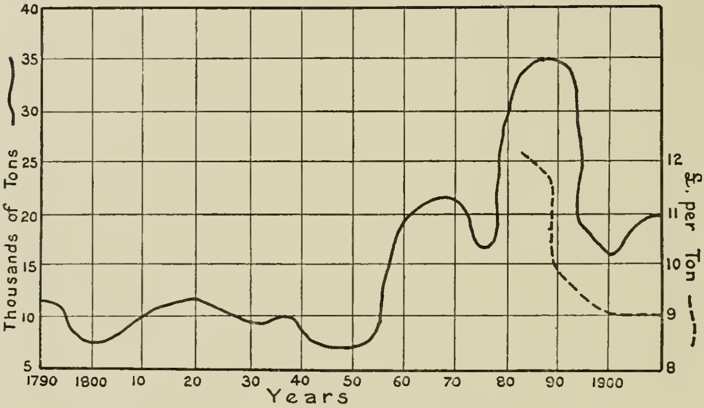

DIAGRAM I.—IMPORT OF LINEN AND COTTON RAGS although the prohibition gave place to export duties at a slightly later date, the English makers found their chief sources of supply in the home and not the Continental markets.[1]

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[1] See Diagram I.

Between 1820 and 1860 the importation of rags only averaged 6,539 tons, a smaller average than in the previous forty years, and a Select Committee sat to consider the question of the foreign duties on rags, and debated the points with more zeal than success. During the same period our export of rags, quite unrestricted, had not been large, varying from 100 to 2,000 tons.[2] Between the years 1871 and 1890 a large growth was visible, resulting from the increased care and interest taken in them, and also the immense importation of esparto.

All through the first half of the nineteenth century there was a marked scarcity in the home supply of rags, which became smaller as time went on. A letter therefore, addressed, in 1860, by Mr. Richard Herring, a prominent authority on the subject, to the parochial clergy and managers of parochial institutions is of interest :—

> "Paper-making demands a supply of rags, and Continental duties at present control that supply. England requires 120,000 tons of rags, and the question is, How can our home supply be increased? Collection of rags has hitherto been by a small trap, and in the hands of petty dealers; the general carelessness of collection and lowness of price have equally diminished the quantity. It has

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[1] Parl. Papers, (Foreign Duties).

[2] See Diagram II.

been ascertained that in scarcely fifty houses out of every hundred is a collection made, and the negligence arises partly from mistakes as to the nature, value, and manner of the due collection.

"It has been commonly supposed that white rags alone are of use in paper-making, but coloured rags generally are useful, and even waste paper can be valuably employed in the manufacture. Every housewife ought to have three bags; a white one for the white rags, a green one for the coloured, and a black one for the waste paper (the three might be furnished for a shilling), and these would prevent litter, waste, and the trouble of collecting when the demand came.

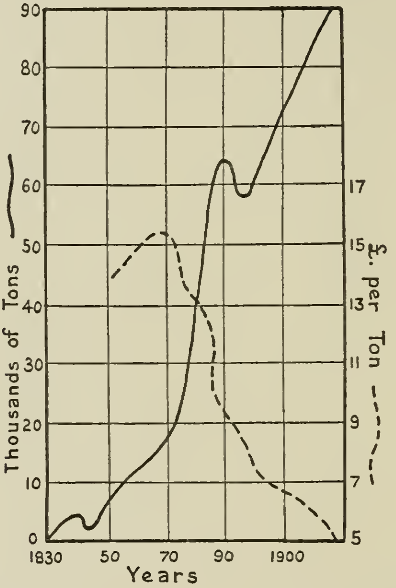

DIAGRAM II.—EXPORT OF RAGS AND OTHER MATERIALS FOR MAKING PAPER

"A suitable agency formed in the towns and villages would settle all demands, arrange the contributions, and reduce the whole into a regular trade. The general apprehension that we require French or foreign rags for our manufacture is a mistake; we have a sufficient supply at home if we will but make use of it. There are more rags wasted, burnt, or left to rot than would make our paper makers independent of all assistance from abroad. A regular communication ought to be formed by country carriage and by railroads for the conveyance of the bags to London, or to those mills in the country which enter largely into the trade. A plan is proposed which will place the whole subject plainly before the public, offer proper pledges, establish proper means, and give the whole movement the degree of activity and regularity which may render it profitable to individuals and the country. A little industry, a little intelligence, and an established system would perfectly secure us from failure in an important branch of art and trade, already worth six millions sterling, employing a large number of skilled workmen, and conducing most effectually to the industry and comfort of the peasantry and to the trade and resources of the Empire."

The knowledge possessed by Mr. Herring on paper-making generally, and rags in particular, rendered his advice of exceptional value at the time. But whereas the quantity of rags in 1860 should have sufficed for the production of paper, the demand has so greatly increased since then that no amount of economy and care in rags would render the total supply in any way adequate to the modern need for paper.

From about 1870 until the last few years there has been but slight stimulus for those engaged in the collection of rags. Many have been discouraged by the low prices paid for the rags themselves, and also by the small price paid for other goods which they had formerly been in the habit of collecting along with the rags. For instance, old sacking, bones, and old crystal were among the materials which they used to pick up on their rounds from house to house. Twenty years ago old sacking was worth from £6 to £9 per ton, but to-day it runs from £2 to £3 10s., and even, for certain qualities, considerably less. Bones also have fallen very much in value; from the price of £6 to £7 per ton they have now fallen to about half that price. Old crystal is nowadays of no value at all.

Nothing would be gained by an attempt to estimate the relative prices of the different kinds of rag, for the differences are so great and so numerous, depending upon quality, that no general figures would be of value. The changes in price were, of course, further complicated by the competition of esparto and wood-pulp. In comparatively recent times rags of all descriptions were at their dearest during the Franco-Prussian War. A fair quality of white cottons would then fetch about £26 per ton, and the same article to-day would probably not be worth more than half the price. In 1880 there was again a very substantial advance in the price of nearly all grades suitable for paper-makers. This was started by the extraordinary demand from America, which in many grades led to a rise of 50 per cent. Cartridge rags and prints, for instance, went up from £10 to £15. The advance did not last long, and prices quickly fell to their former level, and in succeeding years considerably below.

Different countries for the most part provided us with different kinds of rag, and many qualities also came from different parts of the same country. France sends us all qualities of old and new rags, but in the main there are two distinct classes—from the *north and east and from the large towns* comes a fine texture linen rag, which, although clean and of good colour, does not make a strong paper ; and from the *country districts in the south and west* comes a rag containing a lot of homespun linen, which is of great strength and possesses a splendid colour. In general France produces a quality of white linen which is the best for colour and cleanliness in the world, but her cottons, probably affected by the chemicals used in their washing, are thin and tender.

From Belgium come similar rags to those produced in the north and east of France, but not so clean—rather small and tender. To a large extent her sorters are dependent on France for their rags.

In Germany the cotton rags are not very strong, while the linen are rather coarse. The best are used by their own mills, which have to make paper of a certain strength for Government work. Less fine and not so clean as French rags, they are in much smaller demand outside Germany.

Italian rags are tender in the southern section of the country, but fairly strong in the north. Most of those imported to England are white linens of a poor colour, and a few cottons. The export duty keeps the cheaper rags in the country, so that the demand in England for Italian rags is not great.

The staple rag of Russia, strong, dirty linen, which was at one time much used, is now seldom met with in this country.

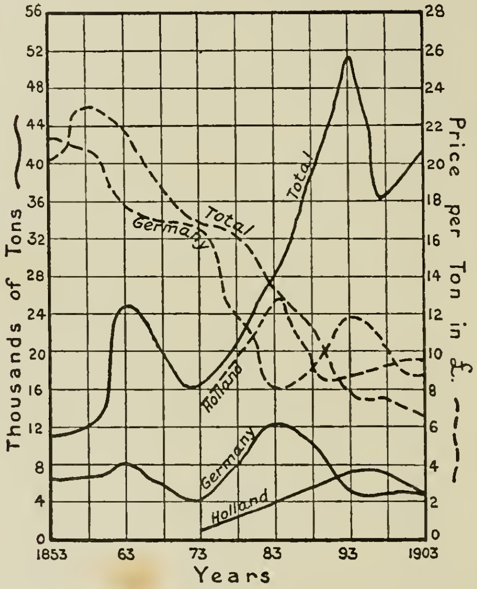

DIAGRAM III.—IMPORTS OF RAGS, ETC., FROM VARIOUS COUNTRIES

Holland sends new cuttings of a fairly clean description, besides all other classes of rags; but few are sorted, and their value is therefore much lessened.

Of the other rags which come from different parts of the world, the small quantity which are sent from Turkey and Egypt are as a rule poor, dirty, and full of vermin.

It may thus be seen that the prices of rags varied according to the supplies from home and foreign sources. Similar causes of variation may be traced in the prices of esparto and wood-pulp which must now be considered. But it should be noted that whereas the demand for rags is likely to remain comparatively constant, and the supply will generally be sufficient to meet it, the demand for esparto and wood-pulp will be continually increasing.

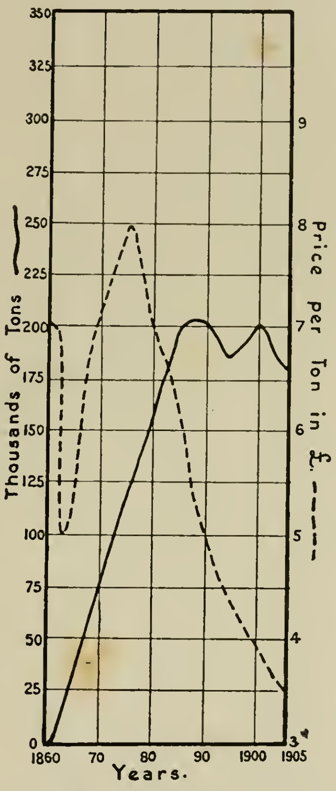

DIAGRAM IV.—IMPORT OF ESPARTO

The only use of esparto up to the year 1860 was for the manufacture of basket-work. Grown in Spain and the north of Africa, its use was almost exhausted by the modest needs of local industry, the annual export not reaching 500 tons.

Before the demand for esparto grass in the paper-making trade, the fields in which it was growing could have produced an aggregate equal to about 220,000 tons. Of this quantity the home requirements did not exceed 25,000 to 30,000 tons, leaving a surplus of 190,000. The utility of it as a raw material in England can be gathered from the fact that whereas in 1861 about 16 tons were imported, in 1887 no less than 200,000 tons came into this country, and about the same quantity is being imported to-day.

From the day when esparto was first in demand for paper-making, the vast quantities, which had hitherto been used for other purposes or allowed to rot, were now devoted to the purposes of the new manufacture. Owing to careless and reckless harvesting, some zones which previously gave the finest esparto became as bare as if the plant had never existed there. If the grass is judiciously collected twice a year the land, so far from being injured, will be improved.

At the present time Algiers, Tripoli, North Africa, and Almeria in Spain, are the chief sources of esparto production,[1] and only a small quantity of esparto is exported from any of these places for other than paper-making purposes.[2] Esparto occu-

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[1] See Diagram V.

[2] A quality of esparto known as "Borde" is sent to Genoa, where it is used for the stiffening of corsets and in place of whalebone. This grass frequently grows to a length of 44 inches, and is thicker and of coarser fibre than the ordinary esparto used for paper-making. But the shipments would only be from 10 to 30 tons yearly! Even the amount used locally is probably at the most only 10 per cent. of the entire production, and in Spain

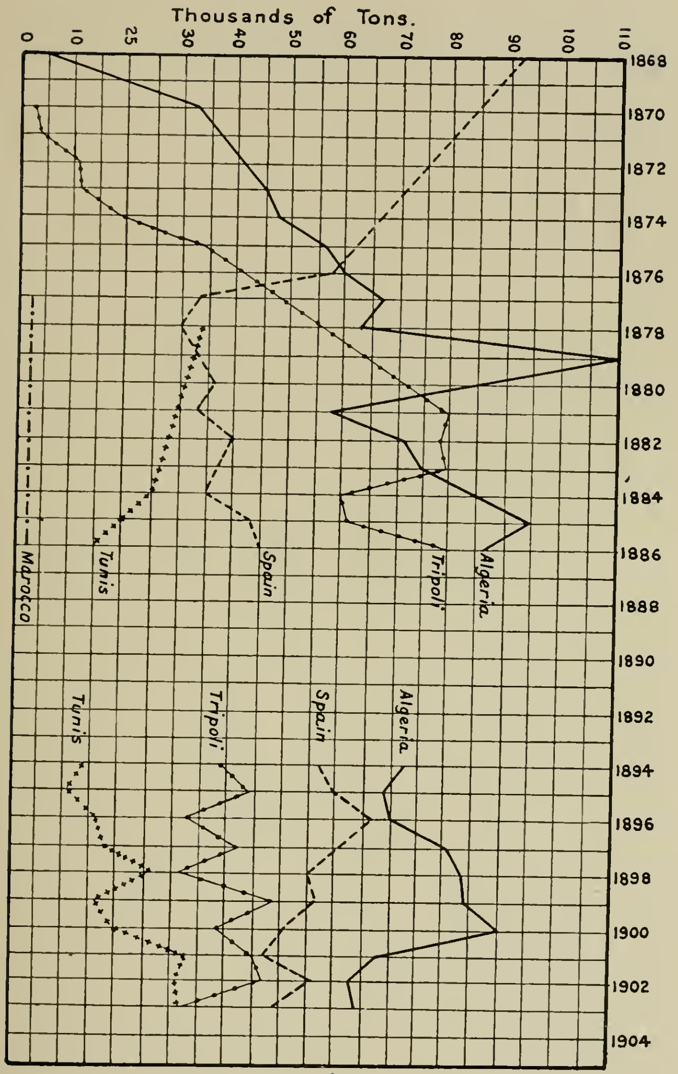

DIAGRAM V.—EXPORT OF ESPARTO

pies about three times the bulk of any other material, and could come to England at what might be called a ballast freight—a ton filling 120 cubic feet. This fact has sometimes been stated as one of the difficulties in bringing it from other countries, where there are no heavy articles of commerce to mix with it as deadweight. But this idea is contradicted by the two facts—that although esparto is sometimes

what is distributed throughout the country is worked for various industries, and therefore only in comparatively small quantities. Basket-making probably consumes the largest proportion. The baskets are used for the removal and loading of iron, copper, and lead, and also of earth and farm manure, while various forms and qualities are made for marketing and other purposes. For the better quality of paper the esparto, after being steeped in water for a certain period, is put under heavy wooden hammers, manipulated by steam, and then heckled. For another kind esparto is used in its crude state, and for another it is first beaten by hand with a wooden maul. In small quantities esparto is also used for bales in which olives are pressed; for casings, or baskets, for sun-dried figs; for mats of various kinds, used for floors, sides of carts, protection of windows from the sun, &c.; for panniers, for mules, and donkeys; for the tying up of the vine branches to the wires after pruning in the early spring; for the soles of shoes; for sandals, used in country districts and made from esparto in its raw condition; for household purposes (after preparation it is used as a substitute for dishcloths, and makes a very effective material for the washing of dishes, and scouring of household utensils and floors); for stuffing purposes, by saddlers and upholsterers; and for the filling of pallets or mattresses for soldiers. Parcels of poor quality are sometimes bought by the Government for the latter purpose.

Indeed if due heed were to be given to its general cultivation, it would in time become a very valuable asset of the country. [Note.—This information has been supplied by Mr. Murison, Vice-Consul of Almeria.]

shipped with other goods, at other times it is exported by itself; and that although plants of a very similar nature have been seen in Turkey, an exact replica has not been discovered away from Spain and Northern Africa.

Mr. Murison is of opinion that some keen and influential person is needed to do for the protection of esparto what Sir Herbert Maxwell has done for the afforestation of land. He thinks it is necessary that the attention of the Spanish Government should be drawn to the need of re-espartising the many bare esparto-producing hills and lands in Almeria, and the neighbouring provinces. Few people realise the extent of the depredations which have gone on in connection with the gathering of the esparto, and threaten to denude the lands which have hitherto been productive.

In 1861 it was used only by Mr. Routledge for the purposes of making paper, and at about that date the price for shipment was £2 per ton, and could be sold here at £4 with a fair margin of profit. Gradually it became scarcer and dearer until it reached £9. Africa was then added to Spain as a source of supply. From 1873 onwards, Tripoli has sent us large supplies of the same quality at a cheaper rate.

Several circumstances have tended to alter the price from time to time, the principal one being that of freight. In 1861 and 1862, 9s. to 11s. a ton was the average price for carrying esparto, but in 1871 it averaged between 25s. to 30s. Since that year the price of esparto has fallen to a sum varying between £3 and £6.

The imports of wood-pulp into this country are a wonderful testimony to the increasing demand of paper. Germany and Russia have added their contributions, albeit small, to the common store, but Sweden and Norway are the two greatest contributors, and of very recent years the latter has

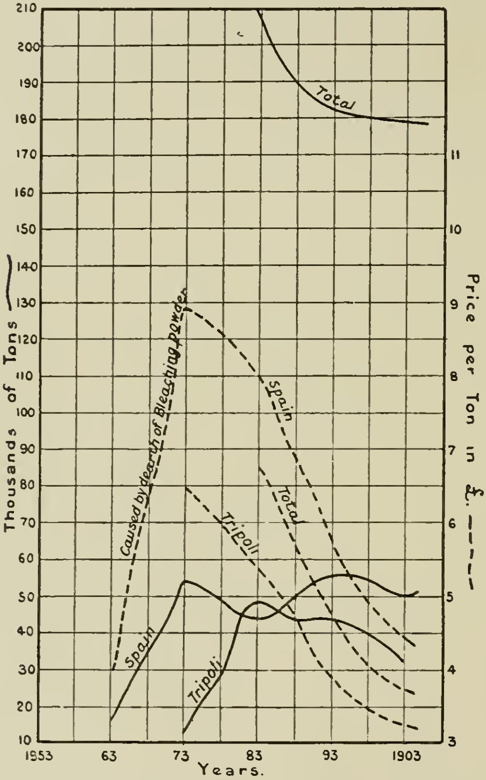

DIAGRAM VI.—IMPORT OF ESPARTO AND OTHER VEGETABLE FIBRES increased her exports to Great Britain at a much faster rate than her larger rival. 79,000 tons was the total import of wood-pulp in 1887, and at the increased rate of some 40,000 tons per annum, this has risen to 568,000 in 1905.

The price on the whole has had a downward tendency, although of recent years, with the shortage of water, the markets have somewhat stiffened. Swedish pulp has varied from £11 a ton in 1873 to £6 per ton in 1903, while that from Norway has touched a figure as high as £9 in 1874, and as low as £4 in 1893. But these prices are not of great value,[1] for the chemical and mechanical wood-pulp were not separated in the Board of Trade returns until 1898, and three years later the returns showed a further differentiation between moist and dry pulp.

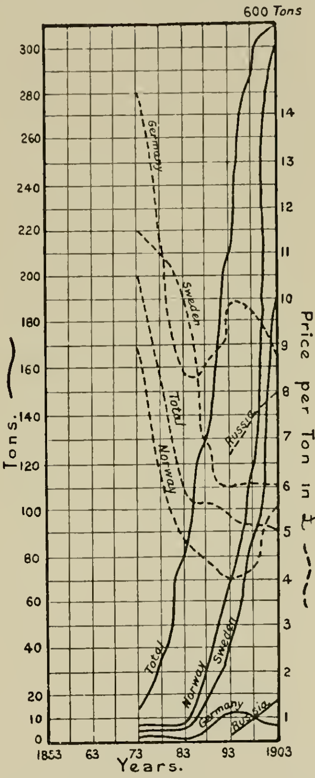

DIAGRAM VII.—PULP OF WOOD

An interesting question arises, one on which decisive views are hazardous, as to the relative positions of Norway and Canada as exporters of raw material to this country. The former, together with Sweden, is likely to supply the bulk of the wood-pulp to this country for several years to come, but some think their maximum supply must be reached before long, as already there are signs of the exhaustion of their timber. It is quite likely that they have sufficient forest lands for the supply of the existing mills, and for some others, but there is no likelihood of enormous development such as there is in Canada. The latter is considered by many to be the future great source of supply, not only for this country but for the United States, and, in a measure, for the Eastern markets.

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[1] See Diagram VII.

At present it is an open secret among paper-makers, that the wood-pulp manufacturers of Canada are quite disheartened in their attempts to do business with British paper-makers. The excess moisture in the pulp has become a vexed question, and there are endless disputes in consequence, which do not, for some unknown reason, appear to arise in anything like the same degree when the Canadian pulp-maker is dealing with the American paper-maker.

The Scandinavians appear to be much better acquainted with the customs of the British paper trade, and although the Canadians are exceedingly anxious to do business in Great Britain, the advantage rests with their rivals.

How far these questions will affect the trade in the future it is hard to say; but so long as the difficulties exist between Canada and England, there is a great chance of the U.S.A. becoming the greatest market for Canadian wood-pulp as well as for cheap classes of Canadian paper.

The establishment of new mills either in Scandinavia or Canada must depend largely upon the water powers available. A large mill grinding mechanical wood may absorb 10,000 to 20,000 h.p., or even more, and the number of waterfalls where the timber is plentiful or readily obtained, is not unlimited. Probably there is more available power in Canada than in Scandinavia, and seeing that the timber resources in the far west of Canada, and in Newfoundland are so enormous, everything favours Canada as the main source of supply for the future.

CHAPTER IV

FROM PULP TO PAPER

WE have now reached the point where our raw material has all been converted into the condition of "half-stuff." We have seen how some of it came in the form of rags from the homes of the people, through the hands of hawkers and rag-merchants, and was passed through a special process at the mill; how other material came from the fields of Spain and North Africa, and was passed through its own special process in the English mills; and how yet a third material was obtained from the forests of Norway, Sweden, or Canada, and was converted generally abroad, occasionally in the English mills, into "half-stuff" of a third description. But whatever our material, it has now reached an intermediate stage in its transformation into paper; it is "half-stuff" in a condition to be treated by a second process, which differs in but a few particulars according to the different kinds of material used. It is proposed in this chapter to consider the method by which the finished product is obtained.

In the first place, the "half-stuff," which it will be remembered has already been bleached, is drained of its water, and pressed, to remove the residual liquid. It is then put into the beating engine, where the remaining traces of chlorine are removed by washing, or destroyed by chemical agents, and the process of disintegration is completed by adding the loading materials, colour and size.[1]

"Upon the management of the beating engine," says Arnot, "the character of the paper to be produced very largely depends." In its ordinary form it consists of a cast-iron trough, in which the bottom is dish-shaped to prevent the pulp from sticking in the corners. This is fitted with a cast-iron roll, called a rag-roll, enclosed all round its circumference with many knives or bars arranged in series or groups, and suspended by its centre upon a malleable iron shaft, running upon side levers. Suitable gear is attached so that the roll can be lifted or lowered at will, and the action kept uniformly equal on both sides.

> "What is wanted from this engine," continues the same authority, "is not a mincing or chopping, but a grinding of the fibres one from another. Long fibres can only be produced by keeping the roll slightly up off the bed-plate, and giving it time to do the work. Sharp action between

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[1] For all papers called "engine-sized," the sizing ingredients also are added at this stage. Hence the term engine-sized, in distinction from papers sized after they are made by being run through a vat or tub, which is called "tub-sized." The former process is used for printings and cheaper writing papers, the latter for ledgers and better-class writings. But the tub-sized papers are also often engine-sized.

the roll and the bed-plate will no doubt chop the stuff up, and make speedy work of the fibre, but the result will be short particles of fibre only, which will not interlace to make a strong or well-felted paper."

The conditions of the beating vary according to the paper required, and the material used. One and a half hours' quick beating will tend to give a bulky, short-fibred, opaque paper, while a slow eight to nine hours' process will end in a fine-fibred, transparent, tough paper similar to parchment. The time, in the case of mechanical wood-pulp is comparatively short, because this fibre has never been chemically prepared, and a certain quantity of sulphite pulp is always added. Rag papers vary in their quality and appearance, according to the time and method of beating, and this part of the process also plays a most important part in the papers obtained from esparto.

Whilst the pulp is still in the beating engine rosin sizing for hardening purposes is added, and fixed in the fibre by the addition of alum. The requisite amount of colouring and mineral matters is put into it at this stage, and the liquid fibre is ready to be run into stuff chests, and thence in carefully regulated quantities upon what is known as the paper machine. The accompanying plates show two plans of paper machines, which are typical of the years 1805 and 1905 respectively. The general principles of the two are almost identical. But they differ in many points of detail—width, length of wire, and the pace at which they run—and it is to

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this difference of detail that the vastly increased output of the modern machine is due.

In the earlier machine the stuff chests (a) were very shallow, being about 3 feet in depth. To-day, though they are made of the same diameter, the depth is from 6 to 8 feet, and they are provided with a revolving arm or agitator to keep the stuff of uniform consistency.

Every modern machine has two or three chests, so that immediately one chest is empty, another is drawn on without any delay. In 1805 it was necessary to stop the working, when the chest was being emptied.

The modern paper machine is fitted with a pump, which continuously lifts the pulp up to a given height, the excess flowing back into the chest. The object of this is to ensure the consistency and the thorough mixing of the stuff, as well as to provide a uniform head, or pressure, to ensure regularity of machine supply on the paper-making.

The 1805 machine had neither strainers which take away dirt, nor sand tables, the stuff going right from the chest to the mixing box, into which were fixed two hogs, (b) or agitators, to keep the stuff moving. The flow from this was regulated by means of the perforated copper slide, (c) whence the stuff passed into the trough provided with another hog, and from there, down an incline on to the wire of the machine. This copper slide prevented irregular flow, and answered the same purpose as the sluices of the modern paper machine.

In both machines the diluted pulp is conveyed on to an endless wire (d) (aa) by a piece of fine canvas, or rubber, and to prevent the pulp flowing outside this, deckle straps (bb) (e) were employed. To-day a cross shake motion of the wire frame unites the fibres, and the wire runs over vacuum boxes (dd), which are subjected to suction. In 1806 there was no shake, and no suction boxes, with the result, that it was absolutely impossible to make paper anything like equal in strength in the two directions of the web, or to draw out the water properly whilst the pulp was on the wire. Another feature, which has become very prominent at the present time in paper-making, is the economy with regard to waste water. An enormous quantity must of necessity be supplied, and wherever it contains any item of value, it is drained off or pumped back and used over again. For instance, there is no waste from the condensed water of the drying cylinders (ee) so far as heat is concerned, and waste water, running over the wire containing chemicals and fibres, is recovered, while a similar economy is effected in the bleach-house with its lime and mis-spent bleach. Economy is one of the notable features of the 1905 machine.

It must not, however, be supposed that in the 1805 machine no attention was paid to the utilisation of waste products. On the contrary, several useful devices may be noticed. As the stuff passes along the machine wire, the water drains through into the save-all below (f), which has a circular bottom at the far end, and in which the backwater lifter (g) revolves. This last piece of mechanism consisted of a number of pipes placed spirally round a revolving axis ; while it revolved, the ends of the pipes were bent at right angles, and the water was scooped up into each pipe. As the pipe reached the top, the water that it contained drained to the centre of the wheel out into a shoot, whence it was delivered into the vat, and mixed with the more concentrated stuff from the stuff chest.

1805.
a.

a. Stuff chest.
b. Mixing box.
c. Copper slide.
d. Wire.
e. Deckle straps.
f. Save-all.
g. Backwater lifter
h. Couch rolls.
j. Press rolls.
k. Reel.

1905.
aa.

aa. Wire.
bb. Deckle straps.
dd. Suction boxes.
ee. Drying cylinders.
ff. Couch rolls.
gg. Press rolls.
hh. Endless felts.
jj. Rolls or calenders.
kk. Reel.

The 1805 machine was 31 feet long and 54 inches wide. That of the present day is 50 feet by 126 inches, and, while the pace of the former was 36 feet per minute, the latter would probably be nearer 200 feet.

Along the wire in both machines the paper passes between two couch rolls (h) (ff) covered with felt, so as to prevent a strong imprint of the wire, and is conveyed through press rolls (j) (gg) of cast iron covered with brass, which squeeze out the water. But where the sheet in the 1905 machine is passed on to drying cylinders (ee), heated with steam, and pressed by endless felts (hh) travelling alongside, the paper, in the earlier method of making, is reeled up quite damp. Leaving the drying cylinders, the paper passes through three rolls, or calenders (jj), made of hard iron, which impart the final finish. It is then reeled and cut into sheets of various sizes.

The material has now been converted into paper in its rough form. But in many cases it still has to undergo certain finishing processes. A stack of eight or ten iron and paper rolls give the supercalendered quality, and a spray of water upon the highly finished sheet causes the effect of an "imitation Art."

Hitherto our attention has been confined to paper made by machinery. There still exists, however, a method by which the paper is largely made by hand. It must not be omitted, for it is the earliest, and, from that standpoint, the most interesting of all. The material reduced to fine pulp in the ordinary manner is run into large receiving tanks standing in the vat-room. A knotter pumps the stuff up into the vat in an almost cold condition, where it is kept at equal consistency by a small revolving apparatus known as the hog.

Across the top of the open vat is placed a brass board, on to which the "vatman" slides a mould, that is to say, a frame made of woven wire, around the rim of which a wooden frame, the deckle, is made to fit. The "vatman" has two moulds in his hand, one of which he seizes, places the deckle on to it, and plumps it into the vat. A very gentle and curious shake is given, as though he were imparting a tremble to the mould, with the result that all superfluous stuff is ejected over the deckle, while the unnecessary water falls through the woven wire. The deckle taken off, the "vatman" slides the mould with its thin sheet of wet pulp across the bridge to the "coucher," and, taking up the other mould which is waiting, he proceeds to go through the same operation with it as before. The "coucher," meanwhile, standing on the opposite side of the vat receives the mould. By his side is a strong rail or wooden fence, across which have been laid many damp warm sheets of felt. One of these the "layer" takes and places flat on the ground, turning the mould quickly face downwards on to the felt. This being warm and damp clings to the sheet, so that the "coucher" can gently raise the mould and leave behind the sheet of paper. Before the next sheet arrives, the "layer" puts another piece of felt over the paper, preparing the way for fresh layers to be added alternately with the felt. This continues until a "post" is completed, and at this juncture the paper, although in a sheet, is only a thin film of soft pulp, which is next carried to a hydraulic press, where much of the water is squeezed out. The "layer" now brings the post back to the side of the vat, and proceeds to separate the sheets of paper from those of felt. Each sheet of wet paper is peeled off from the felt beneath it, and whilst the felt is laid across the rail, ready to be used again, the paper is piled up by itself. A "post" of paper thus obtained, is put between two strong boards, and placed in another press, where it stands for some hours gently "weeping." It is then taken from the press, and left for several days to dry, and after that time the sheets are stripped apart and left ready for the sizing process.

At this point begins the work of the "sizer," who mixes a large tub full of gelatine, and taking a number of sheets, plunges them into this bath of "size," holds them there, and moves them about for a few minutes.

From the sizing-room the paper is taken to the drying loft—a series of rooms filling the entire length of the mill top-floor—the walls of which are shutters opening to admit a thorough draught, the room itself being fitted with hot iron pipes. Dry workers take the sheets, and hang them with care over cowhair ropes stretched across a wooden frame. When the ropes are all occupied, the whole frame is lifted up and fastened into a wooden scaffolding. There the paper is left hanging until dry.

From the drying loft the paper is brought into the picking-room, where a number of girls and women go over each sheet, and pick out the knots or blemishes of every kind with a sharp knife. It is next passed to the glazers, generally women or girls, one of whom lays down a sheet of polished zinc, on which a second lays a sheet of paper, the process being repeated with alternate layers of zinc and paper. Thus several quires are heaped up. A man then takes the entire pile and places it under a heavy roller press. The pile which is now glazed is passed back to a third girl, who simply separates the paper from the zinc plates. From the glazers it goes to the finishers, skilled workmen who go carefully over every sheet, removing every trace of size, stain, or other blemish. They sort it into qualities, and sizes, and pack it into quires, and reams.

. . . . .

Many qualities of paper are made in this country. Under the head of "printing papers" may be mentioned (1) those which are used for newspaper purposes, chiefly made from mechanical wood with a small quantity of chemical; (2) cheap magazine and book papers, made from chemical pulp, to which is added a small amount of "mechanical"; (3) paper for the better classes of books, and litho work, manufactured out of esparto and sulphite material; (4) antique wove paper for other books of a superior value, manufactured from the pure esparto plant; and (5) a small quantity of rag printings—a mixture of rag, wood, and esparto.

"Writing" papers may be distinguished from what are known as "printing" papers. They are chiefly made from rag to which, of late years, a certain amount of sulphite has been added. The papers for the very best work, or that which requires lasting qualities, as, *e.g.*, bank notes, are made almost entirely of linen. For good ledger paper a fair quantity of linen, with a certain amount of cotton, is used, and in the case of paper for account books, the proportion is reversed. Handmade writing papers are made entirely of rags, linen and cotton being used in about equal proportions. For blotting papers, cotton is generally used, and for note and envelope paper, rags, wood, and esparto are the usual materials.

Apart from these familiar kinds of paper, there are numerous qualities for trade and special purposes.

Art papers are used in large quantities at the present time, and the coating for these papers is obtained by adding a certain proportion of glue and satin white, while a commoner form can be made from China clay. In these cases the paper needs no sizing, but they undergo a special process of drying, and the result gives an even surface for the fine half-tone block.

Drawing and photographic papers are usually made from rags ; the former possess a very rough finish, and the latter are practically free from chemical impurities. Brown paper, used for packing, also forms an important branch of papermaking. The materials for these are mostly bagging, common rags, rough waste papers, and wood-pulp, while finer qualities are worked up from manilla and flax. But in really strong " kraft " browns, together with tissues, box-linings, imitation and vegetable parchments, England cannot compete with foreigners. The last of these papers is greaseproof, a quality which is obtained by passing it through a bath of sulphuric acid, water, and weak alkali. In general, the paper made in this country apart from news is of a rather better quality, and higher price as compared with the European and American productions. The raw material esparto is not used to any large extent outside Great Britain, and it has given a particular character to British paper. But while the consumption of esparto remains stationary, the use of wood-pulp is largely on the increase, with the result that there is a tendency for the papers made in this country to become more like those manufactured elsewhere.

CHAPTER V

LABOUR-SAVING APPLIANCES—MACHINERY, CHEMICALS, AND MINERALS

THE difference between the paper-making machine of 1805 and that of 1905 has already been discussed. The vast improvements in method and in output during the hundred intermediate years may be mainly attributed to three causes—the adoption of new raw material, the improvement of machinery, and the more scientific employment of minerals and chemicals. Of these causes the two last remain to be considered ; and this chapter will be devoted to an account of the machines which have come into use, and the minerals and chemicals which have been ingredients in the manufacturing processes of the last century.

Not until the commencement of the nineteenth century was any paper-making machinery invented for changing the pulp into finished sheets. Beating engines, however, for beating the raw material into a roughly pulped condition, had come into use considerably earlier. Of these the Hollander, brought to England in 1770, was the first to produce a fair quantity of pulp by scientific methods. But long before the invention of the Hollander, paper-makers had used simple machines, which were of two kinds. These were known as stampers, and they served to turn the raw material into pulp ready for the vat.

1. The German stamping machine consisted of a long beam with from two to seven holes cut out of it, fitted on the bottom with iron plates. The wooden stamps, four in number, had also an iron sheathing at the base. The hammers were raised by means of the drum, and fell again off them, and, through a hole fitted into a hair sieve in two of them, water was allowed to drain off.

2. The French machine was exactly similar to the German, except that the bottom of the stamps were fitted with a number of small steel nails, instead of a smooth plate of iron. In consequence, the rags were more quickly pounded up.

The stamping troughs were so constructed that the hammers passed exactly along what we may call the right side of the trough, and the trough itself, which extended some way to the left of the beam, was open at its extreme left edge. Each hammer had to be fitted so as to be exactly perpendicular when it struck the bottom of the trough, and in the middle of the trough, on the left side, was a hole through which the water was allowed to drain away.

The output of paper resulting from the pulp thus prepared in the earlier part of the eighteenth century has been estimated more than once, and an interesting statement appeared in the *Wochenblatt fur Papierfabrication*, September 30, 1904: "The work with the stamper takes from 24 to 36 hours; 16 stampers were sufficient for one vat; one vat produces 5,000 per day, and 300 bales = 3,000 reams of paper. From this evidence 40,500 lbs. is the output of one vat per annum, or roughly 800 lbs. per week or 130 per diem. If 16 stampers are enough for this, each stamper would give an output of 8 lbs. per day of 24 hours, but often a larger number is used, and one vat mill may contain as many as 28 stampers. This gives the far lower output of 46 lbs. of dry stuff in every 24 hours."

The small possibility of such a machine was vividly expressed by Dr. Arnot: "A charge of rags of one of these mortars was about 3 lbs., and it took 24 hours to complete the operation. To keep one of the largest of our paper machines at work, no fewer than 5,000 of these mortars would be employed."

In the *Penny Magazine* of September 30, 1833, there is mention of yet another method of preparing the rags at that early period. "The rags were first washed by hand, then placed wet in close vessels until they became half-rotten, and after the fibre was thus nearly destroyed, were reduced to pulp either by hammers in a mortar, or by a cylinder grinding against the sides of a circular wooden bowl." But as no further information in regard to this instrument can be discovered, the extent of its use is doubtful. At any rate, the great need of the paper trade, about the year 1760, was a suitable machine for preparing the pulp.

To Holland we are indebted for the first real beating machine, which appeared in elementary forms before it attained perfection in what is known as the Hollander. As we see it first, it consisted of a large vessel, in which a roller fitted with iron knives was made to revolve. The rags were torn up and ground as they passed between the knives of the roller, and smaller knives fixed at the base of the vessel.

A slightly more advanced form of the Hollander consisted of an oblong, open cistern possessing a partition running along the centre lengthwise to regulate the circulation of the stuff. At the bottom of the cistern on one side of the partition was a block of knives, with edges uppermost, securely fixed, and over this part of the cistern revolved a heavy roller provided all round its circumference with another series of knives. Between the knives of the bed-plate and the knives of the roller bars, the rags, drenched in water, were made to circulate violently by the action of the roller. As the heavy beater rapidly revolved, the rags were cut and torn into atoms and speedily reduced to pulp.

The elementary Hollanders here described contain in essence the features of the modern beating machine. At first worked by hand, they were afterwards propelled by steam or other motive power. By the time they had fully established themselves on the English market, about the year 1800, the amount each cistern was capable of holding was, on the average, 1 cwt. By 1850 this had been enlarged to about 2 cwt., and at the present time in a rag mill, a cistern would hold 300 lbs., although engines containing from 150 lbs. to 200 lbs. are seldom exceeded for hand-made paper. The time allowed in the early part of the century for beating, was from 4 to 8 hours, but with improved machinery it was diminished until, with the introduction of stone beater rolls to replace steel rolls, work which would formerly have taken 3 hours to perform can be done in 1½ hours. By this innovation the possible output was also made much greater, although no saving in power was effected.

It was found that wood-pulp and esparto could be made to circulate round the engine much more freely than rags, ropes, or other long stock. Consequently, with the advent of esparto and wood-pulp, the sizes of beating engines were considerably enlarged, and while in 1865 3 to 4 cwt. would be their maximum capacity, engines for esparto work now hold ½ ton, and those for wood-pulp as much as 33 cwt.

The expense of these large beaters depends upon the horse-power required to work them, and the time necessary to complete the task allotted.

Both vary according to the material which has to be turned into pulp, and to the class of paper required. When working on strong stuff for a rough paper, made out of rope and jute, the time of beating in a 20-cwt. engine is 9 hours, as against 7 hours with the 7-cwt. Hollander. The former, moreover, consumes 75 H.P., as against 45 H.P. in the latter, and yet the amount of power expressed in H.P. per cwt. of material beaten is, in the case of the 20-cwt. Hollander, 33·7, as against 45 H.P. in the 7-cwt. Hollander, a saving of over 25 per cent. At the same time while this large Hollander is capable of holding 20 cwt. of strong stuff, when furnished with mechanical wood it can hold 33 cwt., and this amount of material is beaten in the surprisingly short time of 1½ hours. The proposition, therefore, that a large beating engine is more economical than a small one, is perfectly correct. But tough rags or hard stock has always been, and probably will always be, best treated in small engines. It is impossible to get a high-class bond or writing paper with a large beater. This engine is best suited for the loose, open fibres of wood-pulp or esparto, and is economical because this class of material turns easily in the engine, and wants little propelling by the rag roll.

Most of these economies have been effected during the last thirty years. The diminished cost, for instance, in the Taylor beater over the Hollander, when expressed in H.P. per cwt.

of stuff beaten, is said to be fully 30 per cent. In general there has been a progressive decrease in the consumption of H.P. per cwt. of output, and only a slight decrease in the time required for beating.

Stampers and Hollanders had produced the pulp ready for the vat, but what was badly needed at the end of the eighteenth century, was a machine which would receive the stuff from these engines, and transform it automatically and continuously into a sheet of paper without the assistance of either the vatman, the coucher, or the layer. Nicholas Louis Robert, of France, in 1797 exhibited a machine capable of producing long sheets of paper. Its conspicuous trait was its method of shaking—a process hitherto performed by hand by the vatman. For the actual carrying out of this idea, Pierre Didot, by placing his mill, his workers, and his money at Robert's disposal, gave him the opportunity for experiment which otherwise he would never have obtained.

Becoming intimate with Didot, John Gamble conceived the further idea of obtaining a continuous sheet of paper by machinery. He co-operated with Henry and Charles Fourdrinier, and the two of them induced Bryan Donkin to build a machine which put their idea into practice. From the account of the machine, its principles and mechanism, given by the maker *before the House of Lords*, the improvement of the English over the French machine was made apparent.

A sheet of wove wire made endless, (by joining its ends together) was placed upon two parallel rollers in such a position as to keep the wire extended in a horizontal position. The action of the rollers imparted a forward motion to the wire sheet, and the pulp was made to fall in a uniform stream on to the sheet near that end from which the upper part of the wire moved, and as the sheet moved forward the surface of the wire was covered with pulp. Near that end to which the motion of the wire was directed were placed two horizontal cylinders, at right angles to the direction of the wire sheet, pressing on each other, and including between them the upper part of the wire upon which the paper was formed. These cylinders were turned in a proper direction, and the paper, in passing between them, received a slight pressure. This forced out a considerable quantity of water, and rendered the sheet of such consistency as to bear being removed from the surface of the wire.

On the condition in which the machine had first been introduced to England, vast improvements had been effected. Uniformity of substance could be obtained. A movable apparatus increased or diminished with facility the width of the paper, and rendered unnecessary the expense and inconvenience of having numerous wires and cylinders to correspond with the various widths of the paper required. At the same time the edges were made more clean and perfect.

The machinery for communicating the shaking motion to the wire was so contrived that the number and length of the vibrations could be adjusted with ease to suit the nature of the pulp. Friction wheels relieved the wire from much unnecessary tension, and its durability was thereby increased. The pulp was made to fall on a piece of oiled silk stretched across the machine, which acted like a valve to prevent its running back. The endless sheet of wove wire lasted about three months, and never required changing. In order that the two pairs of cylinders should move with a similar velocity, and so prevent the paper being torn, an adjustable mode of communicating the motion from one to the other was introduced by means of an expanding wheel capable of being regulated by a screw.

The paper, taken from the machine in very long sheets, was cut by a manual process with great ease and exactness, or it was received upon a reel and rolled up.

The machine originally made by Donkin cost about £1,400; his improved model in 1813 cost, for the same capacity of output, £1,000. The time required for erecting the finest and longest machine with latest improvements was then from four to five months, according to local circumstances.

The first machine making a continuous reel of paper successfully was started in 1803 at Frogmore, Herts, and the wire was 4 by 27 feet long. The second machine was started at Two Waters in 1804, and had a wire 5 feet wide, and until 1840 no greater width than this was made.

Current expenses were further reduced, for where on the old small machines five men were employed, three were quite sufficient for the management of the later one, which did not require that degree of attention or skill which before were indispensable.

One piece of wire 24 feet long was used, instead of two, which together were 44½ feet. Now they are made 50 to 60 feet long, and even more. The life of wires has not changed materially. Some works change them every three weeks, and the average time which they can last would not be more than six or seven weeks. Without doubt far more paper is made on a wire than formerly, and this perhaps is the true test.

The paper which was made by hand and by the earliest machines was generally of a cloudy appearance. But the machine of which we have been speaking produced paper of that beauty and cleanness peculiar to the machine-made article.

Naturally these improvements and economies in the manufacture of paper were accompanied by a corresponding increase in output. Where, in 1806, a machine was capable of making 6 cwt. in twelve hours, in 1813 it could turn out double that quantity in the same time at one quarter the expense.

In the early part of the nineteenth century the use of machinery for making paper increased but slowly, while the quantity made by hand remained about the same as before. The number of vats in the British Isles in 1800 cannot, with certainty, be given, but was probably about 800, and it is more than probable that no reduction in this number took place for a quarter of a century, machines being still in the experimental stage ; nor had the enormous demand for paper, brought about by the advance of education, yet had a material effect upon the trade. However, though in 1805 only one-tenth of the total output of the country was produced by machinery, in 1830 as much was made by machinery as by hand.[1]

In 1820 Bryan Donkin issued a *prospectus of his "Wove Machine*," in which he set forth the opinion that, so far as quality and economy were concerned, his method was superior to that used in the production of hand-made paper. He maintained that a stronger and firmer sheet was obtained, and one which, as it required less drying and pressure, could be more quickly turned out. Many other advantages, he said, also accrued from his method. Far less paper was soiled and damaged than in the vats, and cold water could be used instead of warm. Repairs formed but a slight item in the expense, and full use could be made of streams or other available water power. Moreover, the manufacturer could suspend or resume his work at pleasure, being more independent of labour and the perpetual difficulties and loss consequent upon trade disputes, and combinations for increase of wages.

At this period, machines of 30, 40, 44, and 54 inches in breadth were considered to do the work of 4, 6, 8, and 12 vats respectively. As each vat turned out about half a ton a week, it follows that a 54-inch machine could produce about 6 tons of paper. This output became still greater when it was found possible to increase the pace to 40 feet a minute. In 1805 there were 6 machines at work, and 560 tons were produced by them; in 1840 there were 190 machines in existence [1] (though not all of these were in working order) and their output was 33,000 tons.

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[1] See Appendix IX.

To this period belong several other inventions. In 1808 Mr. Dickinson invented his machine for making paper on a cylinder covered by a wire cloth. This he patented in 1809 and soon made into a useful machine.

Another name closely connected with the history of machines in the paper trade is T. B. Crompton, who, in the years 1821 and 1828, respectively, took out patents for drying paper by means of steam cylinders and for slitting paper by circular knives.

For mechanical improvements in the manufacture of paper, 1830 stands out as an interesting landmark. The Dandy Roll, invented by Marshall, to remove some of the surplus water, is now made of wire, and gives the surface of paper its "laid" or "wove" marks, and whenever a watermark is needed it is this roll which carries the name.

The introduction of strainer plates for removing dirt from the pulp made it easier to obtain cleaner papers. This was the work of Ibbotson, who also, with Barratt, discovered an improved plan for water-marking paper, and a method of producing rolls with a greater degree of accuracy. These two men share a high position in this important year.

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[1] See Appendix VI.

We have watched the development of paper-making machinery detail by detail till we have, at length, reached a period when the whole art, as we now understand it, may be said to have been conceived in its broad outlines. Since then there have been many alterations and improvements, but they have been, for the most part, continuations of the same idea. For seventy years the development has progressed, by slow degrees and at irregular intervals, along the path already marked out in 1830.

The introduction of esparto and wood-pulp gave new possibilities for machines. Greater width, increased speed and economy of working became the main objects of the ambitious paper-maker. The late Mr. Edward Lloyd placed an order for a machine at Sittingbourne 126 inches wide, which has run night and day since early in 1876. To-day the width of machines runs up to as much as 170 inches and over; and where the speed in 1870 was some 150 feet per minute, the average will be now nearer 250 feet, the maximum in this country being 550 feet and in America from 530 to 560 feet.[1] This high speed is only possible for making "news." In fine rag papers 60 feet per minute can only be occasionally exceeded without depreciating the quality.

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[1] The fastest paper machine in the world (see *The Star*, Wilmington, Del., Sunday, April 23, 1905) is to be built by American machinists, for the new Newspaper Mill of St. Croiz Paper Company, now being built on the St. Croiz river in the

Of late years there have been numerous improvements which have assisted in adding to the speed of the machine and also in economising time and labour. Of these it is only possible to mention a few of the greatest importance.

The first of the more recent improvements to be considered are those in connection with the driving of the machines. A large range of speed variation is now obtained by the abolition of the old method of change-wheels. Speeds used to be varied by the machine attendant placing pieces of felt smeared with resin on to the two drivers, so as to make one faster and the other slower, but the practice was dangerous, and caused a jerking action in the running of the machine. Among the many types of drivers the best is that which dispenses with all wheels, and has taper pulleys of large diameter driven from a high-speed engine, and so arranged that each section outside the cylinder group can be regulated to any tension required.

State of Maine. It will be capable of producing a finished sheet of newspaper, 150 inches wide, and at a continuous paper speed of 550 feet per minute.

The last machine built for Lloyds of Sittingbourne, Kent, has a wire 126 by 50 inches long, and runs at a maximum speed of 550 feet per minute. It was manufactured, delivered, and started in the remarkably short period of five months from the date of order.

By this means a variation in speed from 12 to 1 can be given without difficulty, and thus all other methods of variation are unnecessary.

In the deckles, too, there have been many improvements. Various bands have been introduced for narrowing or widening the sheet of paper whilst the machine is running, and certain devices are used for raising and lowering the shaking end of the wire-frame, and so altering the shake of the wire.

A second series of improvements are those which relate to the process of drying. More attention has been given to the cylinders than in former times, as it has been recognised that this part of the machine is of great importance. The methods of extracting water have come nearer perfection, and nowadays the cylinder is kept absolutely dry by a patent spiral channel which is fastened inside, and in each revolution empties away all the water.

The improvements in the apparatus for finishing may be briefly dismissed.

An increase in the number of rolls of super calenders[1] saves time and labour; by this means an equal finish may be obtained by putting the paper once through the rolls instead of passing them through two or more times as formerly.

In attempting to estimate the effects of mechanical improvements on the total production of paper in this country, it is hardly necessary to say that the result can only be based on approximate and general figures.[1]

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[1] Chilled iron rolls for giving the paper a glazed finish.

From the statistics that can be procured as to the speed, width, and number[2] of machines, and the corresponding increase in output at the various stages, it appears that the speed has been first in importance, the width second, and last of all the number, the three being in the proportion of 62, 23, and 15 respectively. Doubtless these ratios have varied at different times, but as an average they are as nearly as possible correct.[3] A further cause of variation in the output is to be found in the differences of the raw material used, so that for this reason also we must be content with an average.

In the early periods one machine, working only by day, would produce about 300 tons in a year; later, in 1860, when working day and night, it produced 1,000 tons; and at the present time the average production is from two to three times that quantity, owing to the fact that large numbers of mills employ wide machines running at high speeds.

The reader who has considered this vast series of mechanical improvements may be inclined to think that there would be little or no demand for hand-made paper. Yet the fact remains that such

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[1] The total production of paper in Great Britain up to the repeal of the paper duties has been extracted from the excise returns. After 1861 it is estimated from the amount of imported woodpulp, esparto, rags, and rags collected in Great Britain, as from a ton of each of these raw materials there is a certain amount of paper made, *e.g.*, from one ton of esparto half a ton of paper is made.

[2] Appendix VI.

[3] See Diagram VIII.

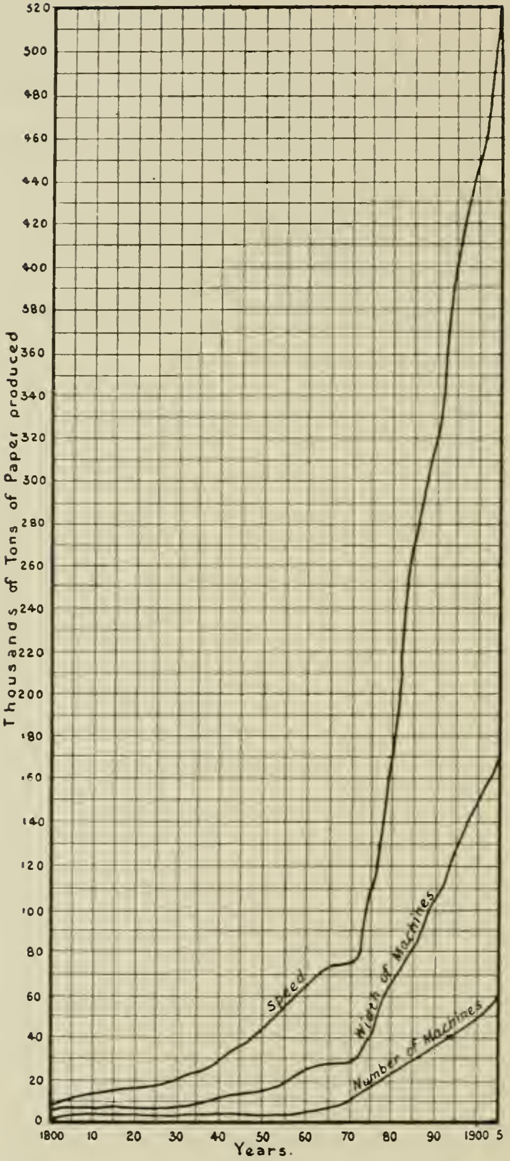

DIAGRAM VIII.—RELATIVE IMPORTANCE OF THE NUMBER, SPEED, AND WEALTH OF MACHINES ON THE TOTAL PRODUCTION OF PAPER a demand does still exist, for there are certain qualities in the hand-made which cannot be obtained by machinery. For a good ledger a hand-made paper is essential, and in general, on account of its lasting capacity, the production will never become extinct.

England has always been the home of this industry, and although a few mills existed in Ireland and Scotland, these are, from an industrial point of view, negligible. The output[1] has not varied much from year to year; 3,500 lbs. have been the maximum of a vat per week, the minimum has been one-tenth of that amount. By 1830 the number of vats in the whole country was probably about 700, but owing to the immense strides made with machines the number fell to 64 twenty years later. A few years later they were increased to 80, and have remained at that number up to the present time. Whilst here and there a mill has stopped working, fresh vats would have been put in at others, so it seems that the level of the trade has been found.

It was only at the beginning of last century that ten times as much paper was made by hand as by machinery.[2] In 1830 the proportions were about equal. In 1860, the year before the repeal of the

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[1] Information *re* output of vats has been obtained from papers belonging to the original Society of Papermakers.

[2] Relative amount of paper made in Great Britain by the hand-made process and machine has been estimated from the number of vats and number of machines.

Paper Duty, hand-made paper was only one-fiftieth of the total production, and to-day 1 ton is produced where 250 are made on the machine.[1]

Minerals

New machinery is one important artificial cause for the increased supply of paper in this country, but it is only one among several others. Minerals and chemicals deserve distinct and separate notice. The part played by minerals for the loading of paper is almost entirely usurped by China clay, which was discovered by William Cookworthy in 1733. It was added to the pulp to give body and weight to the finished sheet. This at first could only be obtained in small quantities, but the quarrying of it has since developed into a large industry. Sometimes it is found within 6 feet of the surface, and sometimes it has to be brought up from a depth of 30 feet.

In 1807 the method of obtaining this clay was primitive, though sufficiently adapted to a time when the demand was limited, when prices were comparatively high from the absence of competition, when wages and royalties were low, and water abundant. In 1870 all of these conditions had changed; the demand for clay was great; prices had been lowered by keen competition; the wages and dues were much higher; and in many districts water was scarce, or only to be obtained in the winter.

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[1] See Appendix VI.

At the commencement of the last century the method of quarrying was simple. The overburden was removed, the clay dug up, and the selected portions wheeled to the stream and washed. As a result of this process much sand was separated, and the clay and finer mica were carried along by the stream to pits and ponds. The pits were rectangular receptacles, built of rough stone and cemented with lime 6 inches wide and 4 feet deep. The ponds were larger receptacles, 20 feet by 12 feet, and 4 feet deep. The first pit received the fine sand and coarser mica, the second and perhaps the third the fine mica, while the fine clay either settled in the last pit or passed on to the ponds. When these were full their contents were transferred to shallow pans lined with granite, where it remained for about six months. By that time the clay was stiff enough to be cut up into square blocks, which were further dried by exposure to the sun, scraped, and rammed into casks.

At the present time the clay is dug from deep pits, and the sand and refuse are eliminated by filtering. The waste products sink, while the clay solution is run into immense pits of about 1,000 tons' capacity. As these fill up there is a sediment of pure clay deposited on the bottom.

In 1876 the proportion of water to clay had been greatly decreased, and this, to a large extent, caused the immense difference between the production then and that of to-day. The water, holding clay in suspension, is let in at one end of the pit, and clear water is run off at the other end. Gradually the deposit of clay deepens until the pit is full, when the clay-carrying stream is diverted to another pit. The wet clay thus left is dried on porous bricks lined with steam pipes, and when thoroughly prepared is ready either for home consumption or export.

For paper-making, the home markets probably take three-eighths and foreign trade one-eighth of the total output of China clay.

So long as rag was the main raw material used, only a small amount of clay was needed. The highest qualities of paper are made from rags, and the addition of much mineral matter would be inconsistent with the recognised high standard of this paper. However, the introduction of esparto caused the consumption of China clay to increase from 7,000 to 8,000 tons. With slight fluctuations this amount has steadily increased, until in 1897 the production of China clay for paper-making purposes stood at 150,000 tons.[1]

All paper contains a natural quantity of mineral loading, but this is by no means large, and where none is added would probably not amount to more than 2 to 3 per cent. An average grass paper has, altogether, 10 to 15 per cent. of clay, and the same may be roughly said of that made from wood-pulp.

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[1] The china clay statistics have been obtained from: "Memoir of the Geological Survey Mining Record, 1853–1881"; mineral statistics prepared by Her Majesty's Inspector of Mines, 1882–1901; "Production of China Clay in Cornwall, 1809–1878," from a treatise by David Loch, 1880: information from China Clay and China Producers' Association, given by Messrs. North and Rose.

Devonshire and Cornwall have always been the centre of this trade, and the latter has provided the superior quality of China clay. During the nineteenth century the quantity quarried has increased with immense strides, from 1,000 tons in 1800, to 400,000 tons in 1900, and of this amount the proportion of Devon and Cornwall has been 1 to 9 (see Diagram IX.)

The price decreased by a considerable extent after the Paper Duty had been repealed, and from being about £10 per ton in 1820 dropped to £4 in 1850, and at the present day is about 12s. 6d. But this is only an average figure, and in 1876 it varied by as much as 20s. From 15s. to 35s. per ton was the price paid.

The general tendency has been for common qualities to fall lower, owing to the increased production and consequently keener competition. For the better qualities there has been an increased demand, and many firms who formerly used the commoner material prefer to pay the difference in price and obtain the improved article. In addition, of the better qualities there have not been as many fresh deposits found, and consequently, higher prices are obtained.

The general use of clay has probably had a deteriorating effect on the quality of paper. But it has also made a greater output possible, has diminished the cost, and so stimulated the consumption of cheap paper.

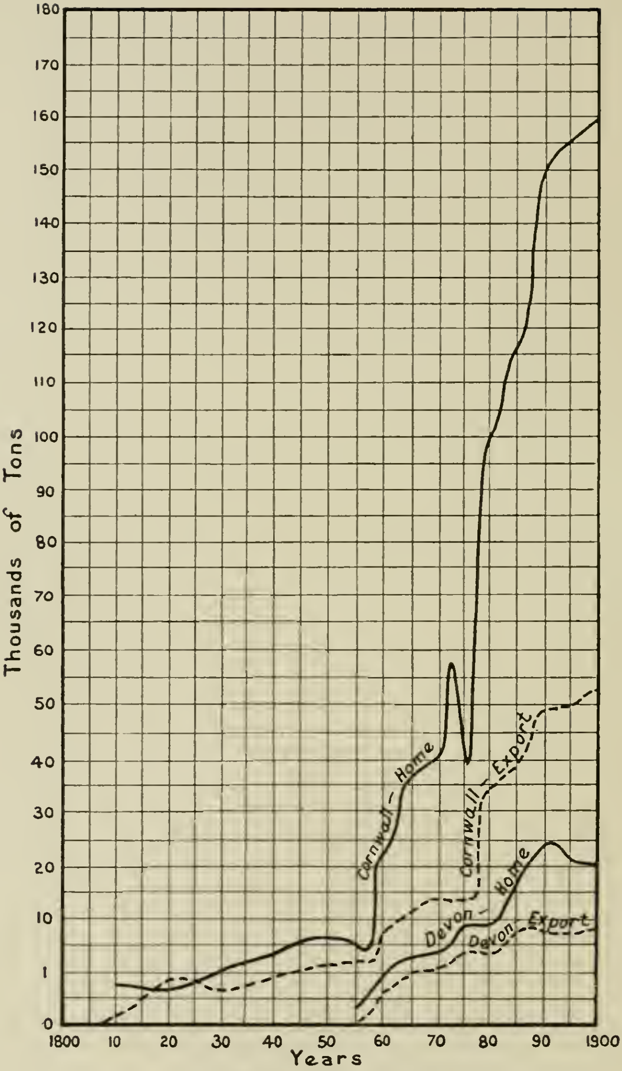

DIAGRAM IX.—CHINA CLAY

Chemicals

Other ingredients have been used in the production of paper. These are mainly chemicals, of which those used in the bleaching and boiling apparatus take precedence. Chlorine was first used for bleaching about 1787. Twelve years later bleaching powder was invented by Tennant, and though during the first half of the eighteenth century chlorine gas was extensively used, the powder gradually took its place. Thirty-five per cent. to 37 per cent. of this chemical has to be added to most kinds of pulp for bleaching, and prices in the last thirty years have fallen from £12 to £4 per ton.

During the time when chlorine gas was still used, the bleach-house contained a number of chambers made of slate, into which the boiled and washed rags were stacked. This chamber communicated with an earthenware still, containing black oxide of manganese and common salt, on to which vitriol was poured. The chlorine gas thus liberated passed into the chamber, bleached the rags, and as soon as the gas was exhausted and the chamber emptied a fresh lot of rags was introduced. It was a long time before this method was given up in favour of that which employed the bleaching powder solution, and as late as ten years ago some mills were still working on the original plan.

Common salt was, for the first time, converted into caustic soda by Scheele in 1775, and Leblanc was able to report that it could be produced with advantage. He obtained the necessary money for the erection of a factory from the Duke of Orleans, and took out a patent in 1791 practically embodying the principles of the Leblanc process, which have been carried out in comparatively modern times.

This process was first used in this country in 1814, on the abolition of the Salt Duty. Muspratt started works at Liverpool in 1823, and soda crystals were the staple material in the paper trade during the greater part of last century for the boiling of rags, either with or without the addition of lime, and the cost varied from £7 to £3 per ton. Before the use of soda, lime was used alone, as it is to this day in some mills, but for the most part it is not regarded as of much practical utility.

The price of caustic soda has varied from £7 to £3 per ton—the big drop took place in 1880, when great improvement and economy were introduced into its manufacture.

The discovery of bleaching naturally leads to the question of colouring—an art which has never reached the same stage of development as in the textile, dyeing, and printing trades; the methods employed are more or less crude and have received less attention. Nevertheless, colours have played an important part in the manufacture of paper.

Whilst in the engine the pulp is treated with colouring matter, which is of two classes—pigments or soluble dyes, the latter generally coal-tar derivatives. The former, being in a very finely divided state, give their colour to the whole stock. They are mainly mineral colours, ground very finely, and added to the pulp in the engine, or pressed direct on the fibre, as, *e.g.*, when chrome yellow is made (by precipitate of lead acetate with a solution of bichromate of potash). The blue pigments are chiefly Prussian blue (made by precipitate of ferria sulphate with yellow prussiate of potash), and ultramarine, which is a mineral colour of a very complicated nature. Oranges, yellows, and reds, are obtained by various shades of ochres and yellows by the addition of bichromate of potash, in solution, to the pulp, followed by a solution of lead acetate. A yellow precipitate of lead chromate is formed on the fibres, which may be altered almost to a red shade by the addition of alkalis. Greens are obtained by a mixture of chrome yellow with Prussian blue.

Dyes, of which there are both direct and basic colours, perform their functions either by entering direct into loose combination with the fibre or being fixed by the agency of some mordant. Cochineal is still used for carmine shades, and the best results attained by using the ammoniacal extract in conjunction with alum and tartaric acid. But the most prominent red dyes are magenta and saffranine, &c., and the alum used in the sizing is sufficient to fix them.

Bismarck brown is used for browns of various shades. Yellows are got by auranine ; there are many shades of green, which are derived from coal-tar ; methyl violet is largely used for violets and red shades of blue. Blue dyes are obtained by the use of cotton and paper blue.

The number of variations now produced by the manufacturers is immense, and of these coal-tar colours are numerous. Each maker has his own system of using these colours, and producing the various shades. The pure colours are for procuring an exceptional strength, but adulteration by means of colourless and soluble substances, such as sugar, dextrine, common salt, and sulphate of soda, is often attempted. In the majority of instances, the use of the pure colour is advisable. In actual use the colours are dissolved in boiling water, and this solution is added to the stuff in the engine.

Alum is next added, and this fixes the colour so perfectly that no tinge will be shown in the water when squeezed out of a handful of pulp. The production of various shades is not an easy matter. Allowances have to be made for the changes which the paper will undergo while on the machine, as the shade of the stuff in the beating engine is never that of the finished sheet.

The beaterman generally forms a small sample by a hand-bowl full of stuff poured on the wire, and the small sheet thus produced is allowed to run through the cylinders, so that when dried it will represent in colour what the paper is to be in its final form.

For heavily coloured papers the ground shade may be obtained by the use of some pigment, and the final shade by the use of small quantities of suitable dyes, till the exact shade required is reached. This method gives a more permanent colour, and one which is also cheaper than the use of a dye throughout the process.

It remains to consider the various forms of sizing, and the process by which the surface is prepared to receive, without absorbing, the ink.

At the beginning of the last century gelatine was the only material used for this purpose, and it must then have amounted to an average of from 3 to 5 per cent. of the total weight of paper produced. All tub-sized paper if hard sized would contain 8 per cent. or perhaps 6 per cent., but blotting papers contain no gelatine, and printing papers at that time very little.

A certain amount of alum has always been used to fix the gelatine in the fibre.

Thirty years ago sulphate of alumina gradually superseded crystal alum, as 2 lbs. of the former would do as much work as 3 lbs. of the latter, and at considerably less cost. Between 1870 and 1900 the prices of alum have varied from £9 to £5 10s., while the alterations in sulphate of alumina have been from £6 to £4, and the general tendency has been to show a steady diminution in price.

During the first eighty years of the nineteenth century paper-makers made their own gelatine, formerly from leather, and latterly from wet hide pieces, and during recent years from the skins of animals. During the last quarter of a century that method of manufacture has been in some measure superseded by the introduction of sheet gelatine made by large manufacturers, and sold to the paper-makers in sheet form. At the present time probably one-half the users are buying it, and the rest are making it for themselves. In 1885 gelatine cost between 80s. and 90s. per cwt., prepared from wet hide pieces. Now it can be made at the mill for 60s., and bought at about 55s.

Its use at one time was practically limited to the purposes of paper-making, until the change effected by the discovery of rosin-sizing. This method (which may be contrasted with the alternative method of tub-sizing already described) depends on the principle of introducing into the pulp a solution of some water-resisting material, thoroughly mixed with the fibres. Some reagent is then added which will precipitate this water resistant out of its solution, and so cause each fibre to be coated with a layer of the precipitate.

The discovery of rosin-sizing is attributed to Illig, of Erbach, and he published an account of it in January, 1806. A few intelligent paper-makers who worked this process at the beginning of the last century had the great advantage of sizing their paper in the pulp, thus rendering the gelatine sizing easier and surer, and requiring at the same time less of the latter material. Much of the paper shipped from France to Germany at the beginning of last century was sized in this way, but in England the innovation made very slow progress; the working of it having been kept secret up till about 1840. Great opposition occurred to the use of rosin-sizing by the foreman who had charge of the gelatine manufacture, as the fat obtained from the bones used in making the gelatine size brought him in a considerable income. To Dr. Wurster is attributed the discovery of its action from a more definite and scientific standpoint, but his investigations were not published until 1877. His work has nothing to do with the commercial use. From 1850 onwards the proportion of rosin to the total output of paper has been 1½ per cent.

Herr Illig carried out his first experiment by mixing the pulp with milk, adding some alum water, which curdled the milk and caused it to adhere in flakes to the fibres; when the fibres came to be made into paper, and dried, it was found that the sheet was satisfactorily sized.

The more modern practice is the use of rosin. This in its raw condition is broken up finely and boiled at 100° C. for several hours with a fairly strong solution of sodium carbonate. A rosin soap is formed, the sodium oxide molecule combining with the acid radicle of the rosin to form resinate of soda, a dark-coloured glutinous mass, and readily soluble in water. In solution it is run into the pulp, and is allowed to work round and completely mix with it. A solution of alum is then added, and although this addition produces very complicated changes and reactions, the general consensus of scientific opinion seems to be that a flaky precipitate is formed partly consisting of free resin and partly of resinate of alumina.

This precipitate fixes itself on the fibres, and, when these are run over the machine, the heat of the cylinders partially melts this coating and so fills the pores of the paper with a very efficient water-resisting medium.

The great advantages of this process are that it is cheap and the sheet of paper is sized throughout its whole thickness instead of only on the surface, as with tub-sizing. In many mills it is the practice to add the alum solution first, and the resin solution afterwards, so as to prevent frothing.

The grade of resin used varies with the firmness of the paper. Naturally a mill making white papers will require a pure, clean resin, whilst one engaged in turning out browns can use a darker coloured and less pure variety.

Starch was in use as a sizing material in 1800, and has been employed extensively ever since, chiefly in the high-class writing papers. To-day about one-third of the papers contain starch, while at the beginning of the last century it had gone to the making of three-quarters of the papers produced. On account of the size of the granules, potato starch is preferable, but there are also the farina and rice materials, and these, if used after boiling to a paste, are as serviceable as that derived from potatoes. The starch is added to the pulp, either by stirring it with cold water and passing it through a fine strainer into the engine or chest, or by stirring it with boiling water and converting it into starch paste. In the latter case it is either added to the engine or chest alone, or mixed with rosin-size. Starch is also widely used in certain forms for the coating of white enamelled papers used for cardboard boxes, and for this purpose a certain form of soluble starch is likely to make great headway in future.

Without doubt Art papers, which during the last few years have been largely on the increase, have created an additional demand for glue, as well as starch and other materials. One-tenth of the weight of coating usually consists of adhesive matters, and the rest is calcium-sulphate or clay, the total sometimes amounting to 50 per cent. of the whole weight of paper. Casein appears to be used far more extensively in America and on the Continent.

The great demand in recent years has been for a large quantity and also for a large variety of papers. The demand has been met with some adequacy, owing to the introduction of fresh raw materials, improvements and enlargements in beating engines, the increased speed and width of paper machines, and the ability to work in conjunction so many additional animal, vegetable, and mineral substances.

CHAPTER VI

A RÉSUMÉ

"IF the consumption of paper is the measure of a people's culture," England during the last hundred years must have advanced a great way on the path of self-improvement. In 1800 we made about 10,000 tons of paper; at the opening of the twentieth century we have reached the respectable total of 800,000 tons, and if to this we add the foreign imports, the total amount of paper used may be roughly estimated at over a million tons. It is not so easy in a single sentence to compare the relative prices of the two periods. An average figure at the beginning of the last century was 1s. 6d. a lb., to-day there is paper which can be bought for ¾d. a lb.

The particular causes which have led to this enormous increase in the volume of the trade and the consequent diminution of prices have already been considered. It remains to sum up their combined results upon the trade in general.

The opening years of the nineteenth century saw the hand-made trade settled in England as a prosperous if somewhat limited industry.

The beginning of its decline coincided with the arrival of the factory system; but the advent of machinery at once caused the makers of hand-made papers to realise that henceforward they would be faced by opposition of another character from that of combined labour, by the more serious and more permanent problem of competition.

The change was slow but sure. It took some time for the new machines to become adapted to the conditions and peculiarities of the British trade. They worked on occasions with great irregularity and little success. They had to face the opposition of public opinion represented in its most violent form by the machine breaker. But the pioneers of the forward industrial policy were not to be diverted from their aim by difficulties of this kind. Gradually they were able to secure markets, and at an early stage the mere fact that they existed tended to lower prices.

By 1830 machines were doing half the trade of the country; ten years later their share was two-thirds of the total output.[1]

The character and quality of machine-made paper as contrasted with hand-made was one of the first points to consider, and a Mr. J. Murray was among the most prominent critics who pointed out its defects.[2] He considered that the manner in which pulp was ground to the finest possible consistency destroyed its fibrous quality, and that the large use of mineral substances, the alum contained in the sizing, and the strong chemical bleaching agents, was bound to injure the quality and permanence of the paper. These arguments were brought forward in 1829, but probably the strongest defence of the early machine-made paper was that it did succeed in satisfying the demand and became the dominant factor in the English trade. The grinding of pulp so as to spoil its fibrous nature was quite unnecessary. It was only resorted to under exceptional circumstances, and if some of the early machine and hand-made papers are closely examined, the grinding of the fibres is just as conspicuous in the one as in the other.

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[1] See Appendix IX.

[2] "Practical Remarks on Modern Paper," by J. Murray.

There is about 2 per cent. of natural mineral matter in paper, and the addition of a substance such as China clay has the effect of increasing opacity and improving texture. Up to a point it may be admitted that these advantages outweigh the disadvantages of diluting the fibrous constituents of the paper with inert and non-cohesive material. Beyond this point the loading prejudices the strength of the paper and generally lowers the qualities of resistance. Increase of loading involves the further disadvantage of increasing the sizing agents.

Such are the opinions of the Committee on the Deterioration of Paper 1898, Society of Arts, and after careful consideration they came to the conclusion that 10 per cent. of total mineral constituents is the extreme limit for papers or publications of permanent value.

Alum in sizing is a necessary ingredient. It is now made absolutely pure, although in 1829 it may not have been so carefully prepared. Somewhat the same principle may apply to the strong bleaching agents, as in 1829 the use of chloride for bleaching was possibly not thoroughly understood. Bleaching agents themselves are quite essential and do little harm to the fibres. In general, Murray's criticisms were premature, and have been in no way justified by the subsequent history of machine-made paper.

In the period prior to the repeal of the paper duty, the numerous inventions all aimed at securing an equally good article at a diminished cost. From 10d. a lb. in 1836, the price gradually fell to about 6½d. in 1859.

Soon after the repeal of the Excise Duty in 1861 esparto was introduced, and its immediate effect was to lower the cost of manufacture and to enable makers to sell at the lower price of 4½d. to 5d., with a fair margin of profit.

The large gains made by some paper-makers, who early adopted esparto as a raw material for their manufacture, stimulated them to increase the size of their mills and provided them rapidly with the capital to do so.

The signs of prosperity, after the introduction of esparto, led to the opening of new mills, and the general development of industry increased the consumption of paper beyond the growth of production.[1] Then for some years production overtook and went beyond the effective demand, large as that had become.

The temporary depression led many paper-makers to reduce by every expedient the cost of manufacture without reducing their output; but this was worse than useless, and merely tended to continue the flooding of the market.

The prices of paper between 1880 and 1890 were steadier, and 3d. and 2d. were the respective prices paid for esparto and wood paper.

Between 1860 and 1902 the average price of paper fell from 6d. to 2d. a lb. This fall may be attributed to three causes apart from the cheapening of raw material:—

1. Chemicals have decreased in value.

2. Fixed charges have been reduced by increased output.

3. Wages, though larger in the aggregate amount, have considerably decreased when reckoned on basis of the cost per ton of production.

Throughout the century there have been five leading factors which go to make up the cost of rag paper:—

1. The price of raw material.

2. The Excise Duty—as long as it lasted.

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[1] This increase, however, will be partly accounted for by the sudden demand for paper in the French markets after the Franco-Prussian War, and the subsequent over-production when this demand ceased.

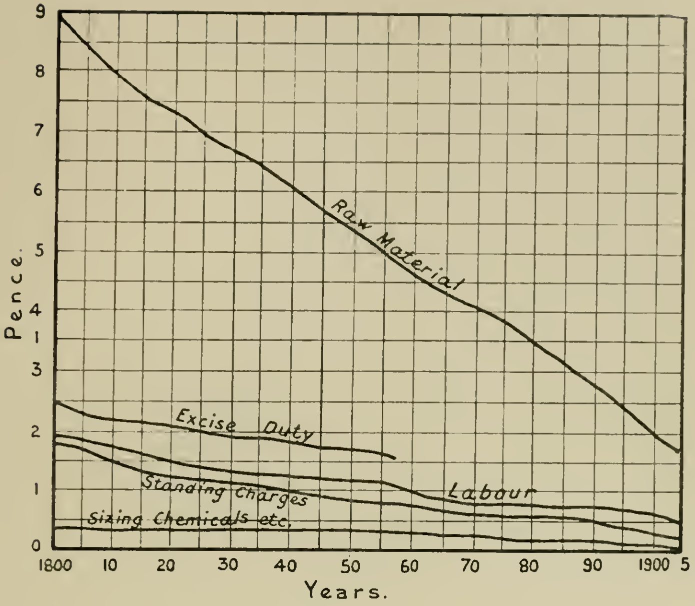

DIAGRAM X.—ITEMS IN COST OF PRODUCTION FROM RAGS

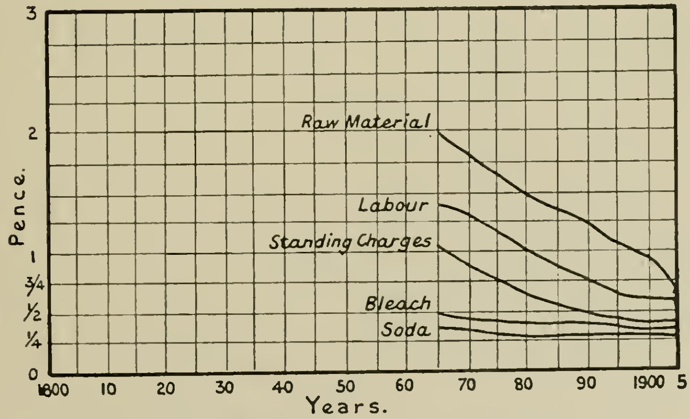

DIAGRAM XI.—ITEMS IN COST OF PRODUCTION FROM ESPARTO

3. The cost of labour.
4. The standing charges of a mill.
5. The value of sizing, chemicals, &c.

Only an approximate and general result is intended to be obtained by the Diagrams X. and XI., as only an average can be taken, and even that on a somewhat speculative basis.

In the case of esparto papers, the chemicals play a relatively more important part than with those made from rags. It would not be possible to compare the figures of a wood paper with those for other papers in use at the time.

CHAPTER VII

THE FACTORIES OF BRITAIN

AS causes exist for the number and character of paper-mills in this country, so there are reasons for the positions on which they are situated.

In the early days makers generally located their mills on streams. Before the introduction of steam engines they entirely depended upon water power for turning their beating engines, and, indeed, as a good water supply is still an essential feature, there is still a reason for remaining on the old sites.

Another reason for their not moving was the important fact that the people from whom they drew their labour supply were established in the villages round about. For whole families would often work in a mill—men, women, and children. They knew no other trade, and when the children grew up the boys took their father's place, work was found for the girls, and the mill was run by successive generations. In other districts skilled labour could not be found, and the importance of the presence of specialised labour had always to be remembered when settling on a site.

As was natural, many small mills became extinct, and often one machine mill had taken the place of, perhaps, three or four vat mills located in a particular district, where a trade, and the goodwill it involved, had already been created. For making high-class papers, not only must there be water, but *good* water, and for this reason Kent, where the water was pure and free from iron and other deleterious constituents, took the foremost place. The Kent water was very hard, and the fine feel in some of the Kentish papers might be in some measure attributed to the presence of limesalts in the streams.

In the case of esparto paper, it became impossible to construct a mill on a trout stream, where the owners would be likely to make very strong opposition to the mill effluent. Manufacturers of this paper naturally looked for a stream where the waste water can be disposed of easily ; but, wherever they went, makers of paper from grass had to contend with the effluent trouble, and this difficulty was only partially overcome by the introduction of the soda-recovery process, which made a mill comparatively innocuous to the stream.

Doubtless in early days local considerations had far more importance in the situation of a mill than at present. There grew up a local demand for paper ; locally they collected their rags, and even their raw material for size-making. Now it is more important that mills shall be near railway and canal transport, so that raw material can be brought from a distance at the lowest possible rate, and the finished article be readily transferred to the widest and best market.

What is even more important at the present time is the means of obtaining coal at a low price. Also with wood-pulp constituting the great bulk of our raw material, a cheap freight for pulp offers a distinct advantage.

One effect of these changed conditions has been the closing of many mills. In general, a paper-mill to-day is either in a rural district on an ancient paper-making site, or is placed in the midst of modern industrial surroundings, near a coal-mine, a railway, or a port.

Kent was the home of the vat trade,[1] and still boasts of more vats within its borders and makes more paper than any other county in the kingdom. At Maidstone, once the centre of the industry, there now only remain Hayle, Springfield, and Medway mills, which are occupied in the manufacture of hand-made papers. The first named in 1830 only had three vats; the second ten vats; whilst the last only sprang into existence as an adjunct to Springfield. The number of vats is now five, eighteen, and four respectively. Many vat works used to stand on the Lea-and-Horse stream in and around Maidstone, among the most important of which were the Turkey, Padsole, Pole, Hollingbourne, and Tovil Mills. The last named has become a machine mill principally employed in the manufacture of rag and wood papers. Some have disappeared entirely, and some have been turned into flour mills.

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[1] Information about the early vat trade has been taken from papers belonging to original Society of Papermakers.

In other parts of Kent there were ten mills, and on the Darenth stream were Little Darenth, Eynsford, Shoreham, and Sunbridge. The first has now increased from four vats to seven, the second and third each from two to three, and at Eynsford, one of the imitation-hand-made machines was afterwards put in. Sunbridge for eleven years has ceased to be a vat mill.

Surrey possessed six mills, and worked eighteen vats; of these Carshalton alone has been working for the last year or two, and may continue to do so.

At one time there were in and around Wycombe, Bucks, no less than twenty-eight vats at work, all of which have now disappeared, those at Beech and Rye Mills being the last to go (in 1891), giving place to the imitation-hand-made machines.

The other districts in the South to possess vat mills in 1830, and after that date were, Hampshire with four mills, Somerset two, Devon five, and Cornwall two.

The Midland Counties were never well represented in the vat trade, and Derby with its three mills, was the only one of much account.

Little is known about the hand-made trade in Scotland, but it is quite certain there were very few mills. The most northern points of the industry seem to have been Yorkshire and Westmoreland, although in the eighteenth century there is mention of one in Edinburgh.

Three mills existed in Ireland producing hand-made papers. Killeen was working up to a short time ago, and about 1890 an additional vat was set up there. But there are now no vat mills and no hand-made paper is produced.

As machinery came to usurp the position previously held by vats, the same sites, wherever possible, were maintained. There is still extant a list of machines built in Bermondsey between 1804 and 1840, wherein are named some of the places to which they were to be sent. Hertfordshire, Kent, and Surrey were each to have five; Buckinghamshire had eight. In the south-west seven machines were to be set up; in the Eastern Counties and Midlands three, while the North was satisfied with two from this source, although it is probable that the makers there and those in Scotland were provided with a certain number of machines from the Sciennes Factory, which was started in 1821, and thirty years later had turned out seventeen machines.

It would be impossible to estimate the various qualities and quantities of paper made in different parts of the country,[1] and at various times, and the amount of money invested in the various kinds of plant necessary for their manufacture, with complete accuracy, or in any minute detail. Only by attempting a general calculation of this description can any conclusions be obtained from the history of papermaking in the United Kingdom.

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[1] The localisation of the output of papers has been estimated from the number of mills, machines, and vats in the various counties, the history of various mills as to the qualities they have made, and from what raw material. The price of these papers from the different prices and paper at the various periods, the

The total output of England, Scotland, and Ireland has throughout the whole of the past century been on the increase,[1] but up to 1860 the various qualities of paper were naturally limited as rags were practically the only available raw material.

The quantity increased during the latter part of the second, and the earlier part of the third, quarter of the century with great rapidity from 30,000 to 100,000 tons. The first idea of how the industry was distributed through the country may be derived from the following Excise regulations.

Extract from McCulloch: Stat. Account of the British Empire, Vol. II., 1837, p. 130.

A Return of the number of lbs. weight of paper made in each Collection of Excise, for the United Kingdom, during the year ending January 5, 1835, *distinguishing the qualities, whether first or second class.*

Note, p. 128.—"*An Excise Duty . . . was fixed on paper in* 1803, *as follows, viz., First-class paper 3d. per lb.; second-class paper, or that 'made of old ropes or cordage only,'* 1½*d. per lb.*" (000 *omitted.*)

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wages paid in different counties, &c. The qualities made in various counties, from information in the Paper Directories, and also from many Paper- makers.

[1] See Appendix IX.

Collections.	1st Class.	2nd Class.
England—	lbs.	lbs.
Barnstaple ...	141	46
Bath	535	146
Bedford ...	83	10
Bristol	397	2
Cambridge ...	705	3
Canterbury ...	984	322
Chester ...	468	44
Cornwall ...	186	297
Coventry ...	150	39
Cumberland ...	237	15
Derby	634	90
Dorset	36	75
Durham ...	1,242	497
Essex	21	—
Exeter	1,802	1,147
Gloucester ...	177	68
Grantham ...	85	35
Halifax ...	2,408	757
Hants	1,612	347
Hereford ...	835	914
Hertford ...	159	—
Hull	17	22
Isle of Wight...	146	32
Lancaster ...	2,246	224
Leeds	1,457	798
Other collections	*over* 1,000,000 *lb.*	
Manchester ...	3,340	1,858
Newcastle ...	1,242	2,443
Reading ...	2,464	712
Rochester ...	4,619	695
Sheffield ...	611	520
Uxbridge ...	7,727	10
Whitby ...	627	206
County Collections ...	43,629	14,210
London ...	1,085	1
Total ...	44,714	14,211

Collections.	1st Class.	2nd Class.
Scotland—	lbs.	lbs.
Aberdeen ...	1,015	246
Glasgow ...	1,047	126
Haddington ...	3,381	22
Edinburgh, &c.	672	663
Total, Scotland	7,467	1,884
Ireland—		
Naas, &c. ...	1,034	102
Total, Ireland	1,874	458
TOTALS—		
England ...	44,714	14,211
Scotland ...	7,467	1,884
Ireland ...	1,874	458
United Kingdom	54,055	16,553

= Total 31,520 tons.

Amount of Duty, £779,122 11s. 3d.

About twenty years later a summary of the number of mills in England, Scotland, and Ireland was given in J. Bradshaw's old Directory. The number given is about 500 mills in the British

Isles, but this must have included some which were not working, as the number given in Paper Mill Directories for this period should be about 400! However, the interest of this record chiefly centres in the distribution of mills through the country, and it shows us how nearly every county was comparatively well represented in the number of mills it contained—a great contrast to the uneven distribution of later years. But the more simple surroundings required then, as compared with the great and complicated demands now, easily explain the difference.

After the Repeal of the Paper Duties in 1861, and the introduction of esparto a few years later, the paper trade of the country naturally underwent severe changes. Between the years 1855–1865 the various qualities of paper considerably increased in number. Rag papers were still far more numerous than those made from esparto. Of the 113,000 tons made in the United Kingdom in 1865, about 25,000 tons would only be produced from esparto, which was chiefly worked in Lancashire and Scotland.

SUMMARY PREPARED AUGUST 24, 1905

Summary of Number of Mills in England, Scotland, and Ireland, From J. Bradshaw's old Directory, reputed to be about 1857, *but probably some years earlier.*

ENGLAND

COUNTY	NO. OF MILLS
Berks	13
Bedford	3
Bucks	29

County	No. of Mills
Cambridgeshire	1
Cheshire	11
Chester	3
Cumberland	6
Derby	10
Devon	27
Dorset	2
Durham	12
Essex	3
Gloucester	8
Hants	10
Hereford	13
Huntingdon	1
Kent	41
Lancs	34
Leicester	2
Lincoln	3
London County Council	21
Middlesex	5
Monmouthshire	11
Norfolk	8
Northumberland	7
Nottinghamshire	7
Northampton	4
Oxford	10
Shropshire	7
Somerset	14
Staffordshire	11
Suffolk	3
Surrey	11
Sunderland	1
Sussex	1
Warwickshire	18
Westmoreland	4
Wilts	7
Worcester	6
Yorks	37
Total	425

WALES

COUNTY	NO. OF MILLS
Breckonshire	3
Denbighshire	1
Flintshire	2
Glamorganshire	1
Merioneth	2
Pembrokeshire	2
North Wales	3
Carmarthen	1
Total	15

SCOTLAND

COUNTY	NO. OF MILLS
Aberdeenshire	4
Berwickshire	3
Dunbartonshire	1
Fifeshire	4
Forfarshire	1
Kilmarnock	1
Kinross	1
Kircudbright	1
Lanarkshire	6
Linlithgowshire	1
Midlothian	26
Renfrewshire	1
Stirlingshire	3
Total	53

IRELAND

COUNTY	NO. OF MILLS
Antrim	8
Armagh	1
Dublin	17
Londonderry	4
Galway	1
Cork	14

IRELAND (*continued*)

COUNTY	NO. OF MILLS
Limerick	3
Clare	1
Tyrone	2
Wicklow	1
Total	52

England	425
Wales	15
Scotland	53
Ireland	52
Total No. Mills in British Isles	545

Between 1865 and 1875 the paper-making industry progressed with some rapidity. It had become accustomed to the new conditions, and at the latter date the total output was 165,000 tons. Scotland and Lancashire had almost doubled their output, and the other districts in which paper-making was an important industry made sure, if somewhat slower, advance. The printing, brown, and cheaper writing papers under 3½d. per lb. comprised about two-thirds, and the more expensive papers were the remaining third of the whole production.

Ten years later the introduction of mechanical wood-pulp had become an accomplished fact, and the chemically prepared pulp was beginning to make its presence felt. 367,000 tons were made in this country, and although Lancashire and Scotland still made the fastest progress, Yorkshire, Kent, Buckinghamshire, and Devon all doubled their output. From this date onwards, with slight alterations, the various qualities of paper may be roughly divided into three classes; the first consisted of news, cheap printings and colours, browns and wrappings; the second, medium and good printings, engine size writings, and better wrappings; the third are too numerous to describe, but include high-class writings. The prices of these three classes were: (1) below 3d. per lb., (2) between 3d. and 5d., and (3) over 5d. The medium quality papers probably represented the largest amount made, viz., about 150,000 tons; 100,000 tons each was the production of the cheapest and most expensive papers respectively. By 1895 the total output had risen to 530,000 tons, and of this Lancashire and Scotland contributed nearly half the amount; Yorkshire and Kent about 60,000 tons each, and rather less than half this quantity was made by Bucks and Devon in fairly equal proportions. The division of prices had fallen to 2½d. and 4d., but the cheapest qualities would take the largest share of the output, viz., about 250,000 tons, the next grade increased to 150,000, and the better-class paper 100,000, a quantity similar to that made ten years previously. At the present time the paper made in the United Kingdom represents some 840,000 tons, and 500,000, 250,000, and 100,000 tons represent respectively the quantities of the different classes. The prices vary from those below 1¾d.

to those above 3d. We may say generally, allowing for a certain number of changes which must have necessarily occurred, that it was in Lancashire and the northern part of England that papers belonging to Class 1 would generally be made, Class 2 would be produced in Scotland, and the better kinds of paper in the English Home Counties.

The amount of money invested in the paper trade has, with the enlarged production, naturally increased, but by no means in proportion to the output. Many things have to be taken into account when discussing values and estimating the amount of capital in the paper-making industry.

The quality of paper that is made must in every case be very carefully considered. In a modern news mill the mechanical and chemical pulp is turned out from the bales into breaking engines, and in about five hours it is made into paper and sent away by rail for printing.

From this it can easily be seen that the capital needed in proportion to the total output would be considerably less than in the case of a paper manufactured from beginning to end by the same mill.

The working expenses connected with a mill having two or more machines are also much less, in proportion, than in the case of a mill possessing only one machine.

The locality in which a mill is situated is another important factor, for upon that depends the question of water carriage, water power, proximity to coals, and to the market in which goods are sold.

In order to compare the different decades, and the amount of money invested in the paper trade at various periods, it has been suggested, after a careful examination into the subject, that a regular figure should be taken, viz., £30,000,[1] as representing the capitalisation of each machine, with all its additional accessories. This machine, however, of course, possesses an ever-varying productive capacity, the variation depending upon the quality of the paper and the date at which it was produced.

The table on p. 107 sufficiently explains itself. Only this comment is necessary: that the difference between the number of machines estimated from the point of view of capital value and the actual number[2] of the machines, is due to the fact that there are always some mills possessing machines which are not working, and others having considerably more than two machines, thus decreasing the capital value of each individual machine. This difference has diminished in more recent years, but the same factors are present and they are only

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[1] Of those machines in the Paper Mill Directory of 1904, where the width is given, the average width and the average production has been taken; also the number of mills they represented. The figures—84 inches, average width; 38 tons, average production; and 2½ machines to a mill—were sent to two engineers (both fully qualified to form some opinion on the matter), and both gave £30,000 as the amount they would suggest.

[2] See Appendix VI.

1875.	1885.	1895.	1900.
110,000 tons output. 820 each machine. Capital enough for 150 machines. 30,000 × 150 = 4,500,000 Under 3½d. lb.	150,000 tons. 1,750 each machine. Capital enough for 85 machines. 85 × 30,000 = 2,550,000 Under 3d. lb.	250,000 tons. 2,700 each machine. Capital enough for 100 machines. 100 × 30,000 = 3,000,000 Under 2½d. lb.	450,000 tons. 4,500 each machine. Capital enough for 100 machines. 100 × 30,000 = 3,000,000 Under 1¾d. lb.
55,000 tons. 440 each machine per year. Capital enough for 120 machines. 120 × 30,000 = 3,600,000 Over 3½d. lb.	100,000 tons. 1,000 each machine. Capital enough for 80 machines. 80 × 30,000 = 2,400,000 Over 3d. lb.	150,000 tons. 1,500 each machine. Capital enough for 100 machines. 100 × 30,000 = 3,000,000 Over 2½d. lb.	250,000 tons. 1,825 each machine. Capital enough for 140 machines. 140 × 30,000 = 4,200,000 Over 1¾d. lb.
	100,000 tons. 500 each machine. Capital enough for 200 machines. 200 × 30,000 = 6,000,000 Over 5d. lb.	100,000 tons. 750 each machine. Capital enough for 200 machines. = 6,000,000 Over 4d. lb.	150,000 tons. 750 each machine. Capital enough for 220 machines. 220 × 30,000 = 6,600,000 Over 3d. lb.
Total... ... £8,100,000.	£10,950,000.	£12,000,000.	£13,800,000.

This estimated table is based on Table of Production and Table of Number of Machines, &c.

counterbalanced by the fact that more money has been spent in the mills on various finishing processes.

In general the capital employed during the last thirty years has increased some 70 per cent., the output more than five-fold; the price of paper for corresponding qualities is, on the average, considerably less than half as much as it was, and if £8,000,000 capital produced 167,000 tons costing 4d. per lb. in 1875, and £1,000,000 produced in proportion at same cost,

we have $167{,}000 \times 4 \times \frac{1}{8} = 83{,}500$,

and in 1905 £13,000,000 produced 840,000 tons at a cost of 1¾d. per lb.; £1,000,000 produced

we have $840{,}000 \times \frac{7}{4} \times \frac{1}{13} = 112{,}308$.

Therefore the return per £1,000,000 has increased in the ratio

$$83{,}500 : 112{,}308,$$

and the profitableness of the capital employed has increased 35 per cent. The paper-making centres have become more concentrated, and so far as England and Scotland are concerned, the outlook is hopeful in the extreme.

CHAPTER VIII

TAXES ON KNOWLEDGE[1]

THE history of the struggle against the "Taxes on Knowledge," as they have sometimes been called, here concerns us only in its relation to the paper trade. The duties which come under this heading consisted of the tax on advertisements, the Stamp Act, the duty on imported paper and raw materials, the Excise Duty on paper manufactured at home, and the licences which had to be taken out by paper-makers.

An Act of the tenth year of Queen Anne put a tax on printed pamphlets, and advertisements, and required a stamp to be placed on every paper known as a "newspaper" under the meaning of the Act. In the course of time these taxes were increased and penalties became heavier for those who omitted in any detail to obey the provisions of the Act.

At the conclusion of the Napoleonic Wars, the paper industry suffered much from the general depression of trade. A complete revision was made in the imposition of taxes, and in 1815 advertisements were only charged 3s., foreign almanacs, almanacs for several years, and perpetual almanacs were subject to a tax of 10s., pamphlets 3s., and newspapers 4d.

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[1] See Appendices III., VII., and VIII.

A year later a similar benefit was accorded to Ireland, and a revision of the Stamp Duty reduced the prices charged to 2s. 6d., 7s. 6d., 2s., and 2d. respectively.

In 1836 the newspaper stamp was reduced to a penny, and definite rules were passed for the size of newspapers, and the charges to correspond, while an accurate definition was given of what a newspaper actually was.

Three years previous to the above date the duty on advertisements had been reduced to 1s. 6d. in Great Britain and 1s. in Ireland, and it was felt by the agitators against paper taxes that discretion was the better part of valour, so that their energy first concentrated on the smallest impositions. Their efforts were attended at last with complete success by the repeal of the Advertisement Duty in the Newspaper Stamps Bill of 1853. This same Act established an exemption from Stamp Duty for all monthly papers, and the liability of a weekly paper was relegated to the Commissioners of Stamps.

From 1853 to 1855 the struggle against the Stamp Act was strenuously waged on both sides. A paper known as the *Edinburgh War Telegraph* screamed defiance against the Stamp Office, and the general protest became so bitter that the

Chancellor of the Exchequer, on January 29, 1855, considered it expedient to exempt newspapers from the Stamp Duty, and to charge on newspapers, printed books, and paper transmitted by post, rates of postage not exceeding one penny for every 4 oz. in weight. His proposal was not carried *in toto.* Certain delays were necessary in so great and important a change, and it was only after considerable difficulty that the repeal of the compulsory newspaper stamp, and the granting of a penny postage to any 4 oz. of printed matter, was completely effected.

The abolition of the Paper Duty had long been the ambition of the Chartists and other ardent reformers. As early as March 24, 1801, an Act provided for the imposition of certain additional duties on paper, pasteboard, millboard and scaleboard, made in Great Britain or imported. These duties were of two kinds, viz., Customs and Excise, Under the former an enormous duty of 10d. per lb. was levied on goods of the first-class, that is, writing, drawing, printing, elephant, and cartridge papers, except those which came from Ireland. Second-class goods, viz., coloured papers and wrappings, paid 4d., browns 2d., and all unenumerated sorts 10d. per lb. Pasteboard, millboard, scaleboard paid 20s. per cwt. Without doubt, the heavy duty on brown paper killed, for the time being, that portion of the trade. From foreign countries the revenue receipts taken in 1818 from all imported paper were only £5,202, and of this £3,108 may be considered as extra war taxes.

The Excise Duty[1] varied from 1d. to 6d. per lb., and was far more profitable from the Revenue standpoint than the Customs Duty had been.[2]

The average amount charged on all paper manufactured in this country worked out from 2d. to 2½d. per lb., and £200,000 were obtained from this charge at the commencement of the century. The British paper-maker had also to obtain a licence costing £2, and, after the erection of a mill, to acquaint the nearest Excise Office with full particulars. All paper made had to be carefully counted and tied up into reams, and in a particular manner; the wrapper had then to be marked with the quality and the rate of duty chargeable on it. At the end of six weeks the Excise Office had to be notified. No weight of less than 1 lb. was used, and the turn of the scale was always in favour of the Crown, although an allowance of 2 per cent. on the total weight was allowed. No paper-maker was allowed to make boards, nor might a board factory be opened within a quarter of a mile of a paper-mill. He had, further, to pay an import duty on foreign rags, and it was hardly surprising that a number of leading paper manufacturers, joined by booksellers and printers, petitioned Parliament for an inquiry. This was granted, and a House of Commons Committee examined them early in 1802. Mr. F. G. Spicer stated that his trade in book papers had been declining since the imposition of the extra 2½d. duty. He thought he should have lost in consequence quite three-quarters of his former business had he not lately turned his mills specially to the manufacture of paper for newspapers.

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[1] See Appendix VII.

[2] See First Report Commissioners of Inland Revenue, 1857.

Mr. J. Bates said that just prior to the duty of 1801 the demand for papers had increased, but that subsequently it had diminished, although, according to another witness, rags had actually fallen in price to the extent of £20 per ton. By the testimony of Mr. E. Chater it was ascertained that the price of printing paper per lb. from 1799 to March, 1801, averaged 14d., whereas after April, 1801, it rose to 17d. The high price of books printed in England, owing to the manifold ways in which paper was made dearer, induced booksellers abroad to reprint them there instead of importing as heretofore. Thus, a book could be produced in Berlin for 4d. which cost 1s. in England.

Temporary but artificial relief was given to the manufacturer by increasing the duty on first-class paper imported from abroad to 1s. 7d. per lb. on brown paper, and that made from old ropes or cordage, 10d. on a dozen sheets of parchment, £3 8s. 2d. on pasteboard per cwt., with the result that the taxes on foreign paper fell to £2,946 2s. 6d.[1]

In 1825[2] the duty on paper was reduced to 9d.

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[1] See Customs Tariffs of the United Kingdom (c. 8706), 1897.

[2] See page 115.

and 3d., and a slight compensation was offered by the reduction to 5s. per ton on foreign rags.

Right through these tariff troubles the output of paper steadily increased, and by 1835 the whole output had increased to 35,000 tons.[1] The amount of Excise Duty had reached the level of £24 per ton, and the total value paid into the Treasury £868,000. One important deduction may be drawn from the fact that the Excise Duty per ton had increased (although the Excise Duties on the various qualities of paper had remained identical for some considerable time), namely, that the better classes of paper were more than ever the predominant manufactures in this country, and that the demand was maintained in spite of impediments (the Excise Duty being equal to more than three times the total wages of workmen, according to McCulloch).

A distinct encouragement was given to papermakers in 1836. The tax became 1½d. on all papers except stained paper and that used for hanging, which was entirely exempted. The result was immediately beneficial alike to the Revenue and the manufacturer. In ten years the output of paper had increased 60 per cent., while the gross duty received was equal to that of 1835. By 1855 the total manufacture had risen to 97,000 tons, and the amount paid into the Revenue was nearly £1,500,000. At the same time it is doubtless true, as was stated in evidence by Mr. Bruce to the

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[1] First Report Commissioners of Inland Revenue, 1857.

CUSTOMS TARIFFS OF THE UNITED KINGDOM ON PAPER, 1823–4 TO 1896. [C. 8706] 1897.[1]

Year.	Brown Paper made of Old Rope or Cordage.	Of any other sort not particularly enumerated.	Parchments.	Pasteboards.	Rags for Paper.	Pulp of Rags.
	Per lb.	Per lb.	Doz. Sheets.	Cwts.	Ton.	Ton.
	s.	s. d.		£ s. d.		
1823–4	10	1 7	—	—		
1824–5	10	1 7	—	—		
1825–6	3	9	10	3 8 2	From July 5, 1825. 5s.	
1826–7	3	9	10	3 8 2		
1827–8	3	9	10	3 8 2		
1828–9	3	9	10	3 8 2		
1829–30	3	9	10	3 8 2		
1830–1	3	9	10	3 8 2		
1831–2	3	9	10	3 8 2		
1832–3	3	9	10	3 8 2		
	Remained unchanged until 1840, when 5 per cent additional upon all duties imposed.					
1842–3	2	4½	—	1 10 0	6	5
1843–4	3	4½	—	1 10 0	6	5
1844–5	3	4½	—	1 10 0	6	5
	With 5 per cent. on amount of duty imposed by 3 and 4 Vict. c. 17.					
1845–6	3	4½	6	1 10 0	Free from	August 1845.
1846–7	3	4½	Free	1 10 0		
1847–8	3	4½	"	1 10 0		
1848–9	3	4½	"	1 10 0		
1849–50	3	4½	"	1 10 0		
1850–1	3	4½	"	1 10 0		
1851–2	3	4½	"	1 10 0		
1852–3	3	4½	"	1 10 0		
			Gilt, Emboss'd Per lb.	Per lb.		
1853–4	2½	2½	2½	2½		
1854–5	2½	2½	2½	2½		
1855–6	2½	2½	2½	2½		
1856–7	2½	2½	2½	2½		
1857–8	2½	2½	2½	2½		
1858–9	2½	2½	2½	2½		
1859–60	2½	2½	2½	Per cwt.		
1860–1	Per cwt.	Per cwt.	Per cwt.	15 0		
	16s.	16s.	16s.	15 0		
	Free from October 1, 1861.					

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[1] See Appendix III.

Select Committee on Paper, 1861,[1] that there was a strong tendency for the trade to fall mainly into the hands of large manufacturers. A good many mills were driven out of the market because the Excise Duty was reduced from 3d. to 1½d.

By this reduction the paper-maker was deprived of a part of his capital, and when the duty was entirely repealed those men who had just sufficient to carry on a business in a struggling way found that they were quite unable to continue it.

The Excise gave the paper-maker a certain amount of capital. He started in business and made paper, sending it immediately into the market. He was paid for it, and was paid not only the cost of the material and labour, but the duty, which he himself did not have to pay for six or eight weeks after he had sold the paper. Thus he had on his hands Government money for the time, and could put it to profitable use.

Through the efforts of those who were working generally for Free Trade in every department of commerce, especially on behalf of paper, the Import Duty was decreased in 1842 to 4½d. per lb. and £1 10s. 0d. per ton on first-class paper and pasteboards respectively. The duty on second-class paper remained the same, and it is of importance to note that a set-back had been given to the reformers two years previously, by the addition of 5 per cent. to all charges imposed on imported paper, and also on that manufactured at home.

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[1] Report from Select Committee on Paper (467) 1861.

The year 1842 had also witnessed the Import Duty on rags reduced from 5s. per ton to 6d., and the pulp alone was charged 5s. In 1845 both were allowed in free, as also parchment, which one year before had only been allowed to come in at 6d. per dozen sheets. Mr. Gladstone's famous financial statement of 1853 followed when he attempted to develop, if not to complete, Sir Robert Peel's work of 1845. 2½d. became the fixed charge for all imported paper, including that made from waste, superior qualities, gilt, embossed, and pasteboard, and from this date began the real struggle between those who wished to maintain the duty and those who desired to see it completely repealed.

Different expressions of opinion were given as to whether the paper-makers were hindered or helped by the various changes which the necessarily accruing duties imposed upon them. Without doubt many troubles existed, and a fair sample of the difficulties to be faced at that period is given from an extract of the 28th Report of the Commissioners of the Inland Revenue, 1885 (4474):—

> "The trade of envelope-making had been rapidly increasing since the introduction of the penny postage system, and had become a very considerable branch of the national industry. At first it was carried on by stationers only, the paper-makers being precluded by law from engaging in it; but in 1850 this restriction was removed, unnecessary as it was found to be for the security of the Revenue, and undoubtedly interfering to a very serious degree with the natural and most economical method of

manufacture. The effect was something more than a mere removal of a prohibition from the paper-maker, to conduct his business to the greatest advantage. So long as the paper-maker was prohibited from making envelopes, the duty, being charged upon the paper before it left the mill, was levied also on that portion afterwards cut away by the stationer in small angular strips. But after the concession envelopes could be made at the mill and charged for duty after being cut from the sheet, and the waste was again made into pulp and reproduced as paper. The alteration was thus of very great importance to the paper-maker, and gave him an advantage over the stationer in the manufacture of envelopes which must have been extremely valuable. It is indeed surprising that the stationers, some of whom carried on their business to an enormous extent, should not have succeeded before 1856 in impressing those in authority with the sense of the injury inflicted upon them. Stationers in 1857 received a drawback on the waste cuttings of envelopes, on condition that such cuttings were reduced to pulp under the superintendence of an officer at a paper-mill."

From this evidence it may be assumed that the fiscal regulations did not press very heavily upon the manufacturer of paper.

Early in 1860 Mr. Gladstone introduced a Bill to repeal the Paper Duty as a whole. It passed its third reading in the Commons on May 8th by a narrow majority of 9. A fortnight afterwards the House of Lords rejected the Bill by 89. This action on their part was regarded by the Ministry as being contrary to the recognised practice in dealing with Money Bills, and a political crisis threatened to follow. Mr. Gladstone denounced the rejection as

> "one of the most gigantic and dangerous encroachments on constitutional usage which has been made in modern times."

and his resignation was considered imminent.

At that time a Customs Duty of 2½d. per lb. was charged on all foreign paper imported. It was felt that the advantage thus accruing to the home manufacturer was adequately paid for by an Excise Duty of 1½d. Mr. Gladstone, in proposing to abolish both these taxes, intended to raise the Income Tax from 9d. to 10d. in order to make up the Revenue receipts. And this seemed a fairly popular idea. But, so far as the paper trade was concerned, the manufacturers maintained that the scheme should have included a clause continuing the Import Duty on foreign paper to about 1d. per lb. Their argument was based on the idea of retaliation, for many foreign countries imposed a heavy and oppressive tax on rags.

General indignation was expressed at the high-handed action of the Lords, and Parliament was bombarded with petitions on the subject. It was generally understood that there was some difference of opinion between Mr. Gladstone and Lord Palmerston as to the repeal, but the former is said to have made a special point of the matter, and to have threatened resignation. In 1861 the Paper Duty appeared for the last time in our accounts of Revenue. In the Budget of that year Mr. Gladstone included its repeal, and while he estimated the loss to the Revenue from this abolition to be under £700,000 the Opposition felt sure it would be a matter of £1,500,000. The Chancellor had, in his calculations, remembered to deduct the amount of the various drawbacks on the tax, and the expense of collecting. His opponents had forgotten these elementary facts.

This year enabled the reformers to see the culmination of their efforts and a practical result to their labours. On May 18th, Mr. Gladstone moved that the Paper Duty should cease on October 18th, and his resolution was passed by a majority of 15. Both the Import and Excise Duties were taken off, and while the British paper-maker might be considered to have lost the "protection" afforded him by the former (amounting to £229,743) the repeal of the latter relieved him from £1,350,000 in taxation on his produce. However, the paper-makers for some time afterwards did not consider that the change was in their favour. So long as they could retain the Customs Duty as a hindrance to foreign competition they were ready to put up with the Excise Duty which they could transfer to their customers.

Among the notable protests which had been made before the repeal was effected was that of the deputation of paper manufacturers which waited upon the Chancellor on February 18, 1860.

They argued that the materials from which paper, up to that time, had been manufactured, were almost exclusively waste products, such as rags and the refuse from the linen and cotton manufactures, although straw had also been employed for the commonest description of paper. That, notwithstanding the long-continued high price of rags, both in this country and America, and the large reward offered for the discovery of any substitute for them in paper-making material, none had been found.

Finally, they argued, the export of rags was prohibited on the Continent, and rags were, consequently, cheaper in those countries. For these reasons they suggested that the Government should not persevere in proposing the abolition of the present differential duty of 1d. per lb. on foreign paper or cardboard, except in the case of countries from which the free export of rags is permitted. If they persisted, they predicted ruin for the trade, in the business of which capital to the extent of £3,000,000 had been embarked.

A trade journal, *The Paper-maker's Circular*, wrote as follows in their opening number :—

> "With reference to the all-important matter of foreign papers, having had considerable opportunity of knowing and observing what is taking place in Continental production, so far as respects quantities, the importations have been trifling—but their prices were certainly producing a good deal of mischief for the time being to the British maker, although it can hardly be said that they were cheaper. If we take the old rates of 6¼d. and 6½d. as representing the lowest price of anything worth the name of printing paper, the absence of any duty would bring the price to 4¾d. or 5d. for common rag paper. The foreigners seem to supply a good deal of this at 4½d. or 4¾d. At these prices, on the average, they are a shade better than

ours in colour, just a trifle cleaner, but generally have a most objectionably rough surface, or are miserably poor in handling by excessive loading—points which make them very difficult of sale in the hands of the dealers.

"To recapitulate—quality for quality, they are hardly cheaper; the character of their make does not suit the trade."

An obvious remark can be made on this conclusion. If the quality of these foreign papers were in general so inferior to the English article, what was the reason for dreading their advent? It could only have been that the makers either had not confidence in their own work or in the English demand for a good paper.

In their ninth number the same journal had something to say on what the abolition of the duty had effected:—

"The repeal of the duty on paper has now been upon its trial for nearly half a year, and in considering this subject we will weigh it in no narrow technical scale, nor resort to any special pleading in endeavouring to prove that, as an act of Legislature, it has been a huge mistake. From the commercial point of view it has been utterly unproductive of any stimulus to any branch of our national industry, while it has seriously compromised the well-being of the numerous and important interests connected with the production of paper. Paper, being an article necessary only as an auxiliary to our wants and circumstances, and not a cardinal or essential need, is limited in its consumption. Since the abolition of the duty has not increased the consumption in the slightest ascertainable degree, and has lost for the revenue a useful and ungrudged tax, without in any way creating a compensating effect of additional employment, or imparting a stimulus of any kind to any branch of our industry, we are surely justified in asserting that a huge Legislative mistake has been made."

On the other hand, it was stated that the British paper trade was largely benefited by being emancipated from Government interference in the conduct of its business, and the makers were not compelled to retain the official numbers that had hitherto been attached to their mills.

To sum up, the probable effect of the repeal was, that after the excitement was over, the British paper-making industry went on in the same way as in earlier days, the change that ensued being brought about in a gradual and natural way. Paper-makers had been delivered from much harassing red tape, and at first were not greatly affected. But soon they had to bestir themselves to meet the rapidly growing competition from abroad.

The imports of browns increased by about 475 per cent., those of mill and pasteboards some 550 per cent., and those of printings and writings by 400 per cent., between 1860 and 1862. The increase was mostly caused by the English manufacturer considering that the high price which had been due to the tax might reasonably be retained, and that he need knock off only ½d. or 1d. from the old rates. For some time the arrangement held good, but towards the close of 1861 consumers declined to order at the old prices, preferring to buy the foreign paper at a cheaper rate. This action of the paper-makers gave the foreign manufacturers their chance of cutting prices, and establishing themselves in the trade.

The paper trade languished until about the end of 1865, the makers vainly endeavouring to induce Parliament to give them support, to counteract the effect of duties placed on the export of rags by various countries.

The introduction of esparto and a very successful publishing season caused a fresh demand for paper, and the trade were enabled to raise their prices. From this point the production of paper has never gone back. Within seven years after the repeal the total output had increased some 33½ per cent., and in this year the last remnant of "The Taxes on Knowledge" ceased, with the abolition of licences.

Without doubt, the total gain to the public has been great. For the paper trade in general a new era was commenced, a wider demand for literature and newspapers was coincident with the industrial progress of the time. The repeal of the taxes had preceded the advent of popular education, and the enormously increased demand for books, periodicals, writing material, &c. From this time onwards the trade has increased by leaps and bounds, till it has attained a really important position among British industries.

CHAPTER IX

USE AND DISTRIBUTION

IT is the function of the wholesale stationer to distribute the finished article which the manufacturer has produced. The paper-maker turns the raw material into paper, which he has then merely to sell in the open market. The wholesale stationer is largely the medium through which this completed paper is distributed among the traders and large consumers.

The term "distribution" will not here be used in the limited sense it bears in economics; for the practical purpose of the present work it must be understood to have a much wider significance, including many subsidiary operations, the carrying out of which fall upon the wholesale stationer. For instance, he will be concerned with the parcelling out and distinguishing between the goods which he has bought in large quantities.

The distribution of paper throughout England forms a very interesting branch of the trade, and has gained an added importance owing to the great and growing variety of the different kinds of paper manufactured at home and in other parts of the world. Every improvement, every utilisation of a new raw material in the manufacture, and every addition of variety and cheapness have tended to increase the demand. All these have ministered to the spirit of enterprise and desire for novelty so largely developed in recent years. Catering for modern demands has become a science. The clever consumer or distributor has readily caught at new qualities of paper, whether these have varied in suitability, colour, appearance, thickness, or texture.

The paper buyers of the world are divided into four classes :—

1. The distributor, generally called the wholesale stationer.
2. The general newspaper, magazine, and book publishers.
3. Printers, stationers, bookbinders, box-makers, manufacturers of every description of article produced from articles which are themselves manufactured.
4. The whole population—of which every individual uses paper in some form or another, but not until it has gone through some intermediate process of manufacture since it left the makers' hands.

The paper-maker cannot come into contact with members of the fourth class. His direct dealings must be with one or more of the first three classes, and in the present state of the trade his relations with the first class are still the largest.

For this fact there are several reasons, which constitute the *raison d'être* of the wholesale stationer.

Speaking generally, he is able to distribute the paper-maker's product as economically as the manufacturer himself; while through his wider knowledge he is able to give the average consumer a larger choice and later information.

The ordinary consumers in class 3 use a great variety, but the quantities of each paper required are comparatively small. The wholesale stationer holds and regulates stocks, so that from this large field of small orders he is able to make up a large order for the paper-mill. This point is one of enormous importance to the paper-maker. For economical production the mill wants the largest possible continuous running on one grade. In the majority of cases the tendency in recent years is for paper-makers to produce few qualities. Each of the mills specialises in some few grades. If a maker wishes to do direct business with class 3 he has to abandon that policy very largely, and incur the travelling expenses for collecting, and the charges of stocking paper for small orders.

The amount of credit of necessity required by some members of class 3 does not harmonise with the prompt payments required from paper-makers by those who sell to them raw materials. Gradually the wholesale stationer has become the main distributor to class 3. Accumulating large stocks, and all the latest varieties at his different warehouses, he sends his traveller everywhere. Orders are taken for comparatively small quantities and delivered without waste of effort. He allows the use of his capital in extended credit, and there are comparatively few belonging to class 3 who have not been glad of this service during the earlier period of their business careers.

Although the question of eliminating the middleman is often discussed, there seems to be a distinct place for him in the paper trade. The wholesale stationer is not only of real advantage to the papermaker in enabling him both to distribute his goods and run his mill economically, but he also frequently supplies him with information as to special needs, and keeps him in touch with what others may be doing in different parts of the world. Samples are issued with the object of showing the sort of work which each mill is best capable of producing—and in general of rendering a service which the average manufacturer appreciates, and for which the remuneration obtained in a comparatively small commission is found in the long run to be profitable.

Great Britain and its colonies have for years past been in the front rank of paper consumers—one of the results of the general and improved condition of the people. Everybody is a consumer more or less, and whether it is more or less depends upon his condition. Those interested in the paper trade have, of course, not been slow to do all in their power to stimulate the consumption.

The open-door policy has at times enabled manufacturers to produce specialities of very cheap papers; these specialities are distributed by the wholesaler to hundreds of thousands of consumers at home and abroad.

On all questions connected with carriage by rail, water, and road, the wholesale stationer has been compelled to keep himself well informed. Warehouses have been established in different parts of the country to save double carriage, and information imparted to the great railway companies in connection with the classification of goods. These companies, some years ago, suggested a new classification which would have worked unfairly, and contained proposals prejudicial to some grades of paper whilst relatively favouring others. At a consultative meeting between members of the paper trade and railway managers—those representing the former were able to show that under the proposed alteration brown paper used by a maker of boots would have been charged on a much higher scale relatively to value than paper used for the London School Board copy-books. As a result of the conference, a far simpler and more equitable method was devised. All papers were divided into two classes—an arrangement which worked well, and was for the general advantage of the trade, up to a certain time, but now, owing to the decline in value, needs to be reconsidered.

Another great change in which the wholesale stationer has been able to play an important part is the substitution of specialisation for standardisation. In the earlier days of the paper trade, and especially when the bulk of the paper was hand-made, there were comparatively few sizes, and these sizes were in comparatively few substances. Machinery altered this, and to-day every newspaper wants a special size and a particular appearance, every author and every magazine editor wishes to have his book and his volume produced in a particular fashion. Every advertiser wants his pamphlet to be of a characteristic and attractive nature. For these ends the wholesale stationer has, through his knowledge of the sources of supply and possession of expert information, assisted in no uncertain manner.

Further, the methods employed by the distributor to-day are very different from the methods he employed at the commencement of the century.

About 1800 there were no railways, penny post, electric telegraph or telephones, and as the paper-mills were scattered over all parts of the country, most of them in secluded rural villages, the stationer who relied on a number of mills for the paper which he sold, passed much of his time on the top of coaches, in his gig, or on horseback, going from mill to mill to give orders, and to see that those orders were duly executed. The work of the middleman, which was at first of a very rudimentary character, in the course of time attained a recognised importance.

To-day the office of the wholesale stationer is organised in the most detailed manner. The buying department forms perhaps the basis of the business, for it is from clever buying as regards *qualities* as well as prices that the wholesaler gains his power of selling in the best markets and to the greatest advantage. The selling is done through the agency of travellers, counter trade, and sampling. The travellers are continually opening up new connections, and endeavouring to maintain their previous *clientèle;* certain people will always come and buy from the central establishment itself, while attractive samples of various qualities of paper will be sent into towns where suitable customers are known to live.

The various orders will be entered out in the various departments, perhaps for the London market, possibly for country use, it may be for export. A counting-house draws together the financial reins of the whole organisation into one hand, and a check is kept as to what profits the departments show on their respective workings.

A certain distributing trade is done from the paper-mill itself by means of a class of men known as paper agents, who serve as intermediaries between the paper-maker and the wholesale stationer. Each of these represents one or more mills, and for a commission sells nothing but the papers of those mills to the wholesale stationers or other large buyers.

If proper care and forethought is taken, the future of the wholesale stationer should be perfectly secure. As it is comparatively simple to work out the cost of production, so it should be possible for the cost of distribution to be estimated. If a progressive spirit continues to dominate those interested in distribution, it will be possible and profitable for it to continue as a separate entity from that of production. Finally, it may be said, the distribution of paper throughout the United Kingdom has naturally grown in proportion to the increased production and also the number of qualities made.

The export of paper to foreign countries began at an early period, when the bulk of our foreign trade was increasing in every direction. In the early part of the nineteenth century there were two great factors determining the course of British industry: (1) the introduction of machinery, and (2) the Napoleonic Wars.

The former of these causes had many results, and not the least momentous was the fact that being first in the field we gained access to foreign markets producing cheaply and selling at a corresponding advantage. The seventeenth-century idea was that prices at all hazards must be maintained at a certain level; and only with the advent of new mechanical devices did the truth slowly dawn upon the Anglo-Saxon mind that the old mercantile system encouraging exports and discouraging imports was unsound, and that markets were won by selling cheap. Shut out as we were by Napoleon from many markets, we naturally drew more closely to those to whom we were as indispensable as they were indispensable to us.

The first country to which we exported paper was France, and as it happened it was also to England that France sent her first export of paper. She had attempted to anticipate England in the machine-made article, and was generally eager for the paper trade to flourish.

Belgium also, with the famous beating engine, sent us paper, and in return we sent to them some small quantity. Towards both these countries our debiting was larger than our crediting strength. A scarcity of rags prevailed in the home markets, little more existing than sufficed for our own wants. In foreign countries there were import duties on the manufactured article which were sufficient to make trade with this country unprofitable even if we had had the paper to send them.

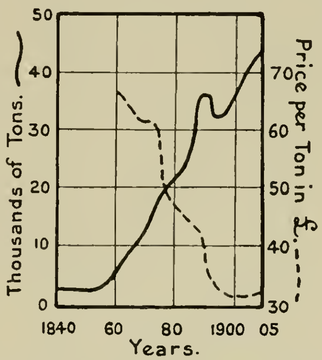

DIAGRAM XII.—EXPORT OF PAPER

After 1850 the export of paper[1] began to be of considerable importance (Diagram XII.), and between 1852 and 1853 this export increased from just over 3,000 to nearly 6,000 tons.

A year later there was a further slight increase, but in 1855 there came another sudden drop, followed by a sharp recovery in the following year, from which date there was a steady

[1] See Appendix IV.

growth up to the time of the repeal of the Paper Duty.

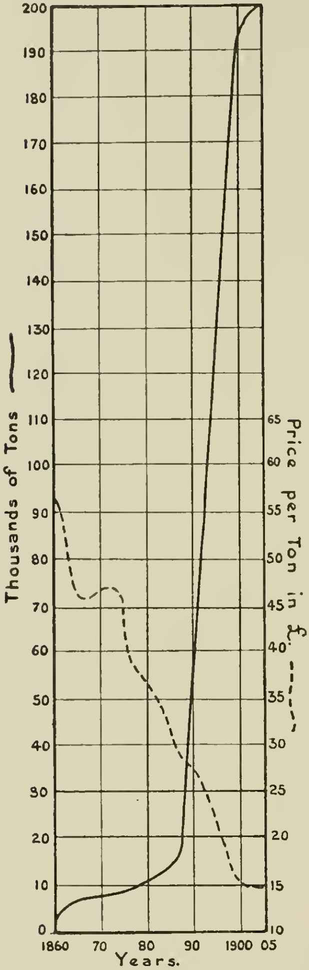

DIAGRAM XIII.—IMPORTS OF PAPER FOR PRINTING OR WRITING

With the abolition of taxes on paper, the importation of foreign paper[1] became of considerable importance to the English market (Diagram XIII.). Prices dropped within two years 1½d. a lb., and the German and Swedish manufactured article increased from a negligible quantity to some 10,000 tons in 1873.

When, however, by about 1875 the utilisation of esparto had firmly established itself as the leading characteristic of the British industry, foreign paper, from being one-seventh of the entire British consumption, fell to about 8 or 9 per cent. The general dislocation of the paper trade resulting from the rise in imports, the scarcity of English rags, and the increased duty placed by Italy, Prussia, France, Belgium, and Holland on their rags caused a decline in our export trade in 1861, but it soon began to revive again. During the following year 10,000 tons were sent out, and in 1872, at the commencement of the second decade after the famous paper legislation, a sudden increase took place to the extent of 5,000 tons. France (Diagram XIV.), devastated by the Franco-Prussian War and all its evil consequences, opened her markets to all producers, and English papers, amongst other commodities, shared in the general advantage.

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[1] See Appendix I.

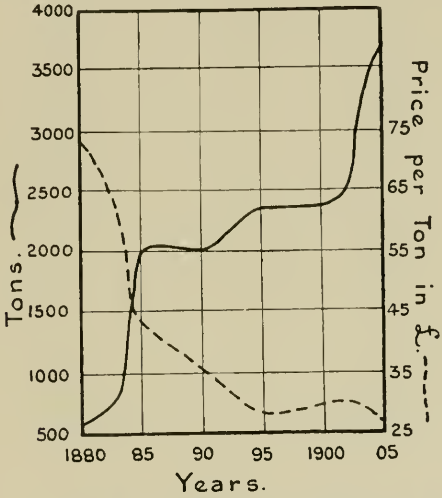

DIAGRAM XIV.—EXPORTS OF PAPER FROM GREAT BRITAIN TO FRANCE

This temporary increase in the Continental demand for English paper was followed by a slight reaction during the next few years; but the decline was not permanent, and by 1877 it had reached the same high figure, and ten years later had attained to the level of 38,000 tons. Indeed, the most important thing to be noted up to 1887 is that our exports exceeded our imports of paper.[1] We had become large consumers of esparto, and therefore to a certain extent independent of foreign supplies.

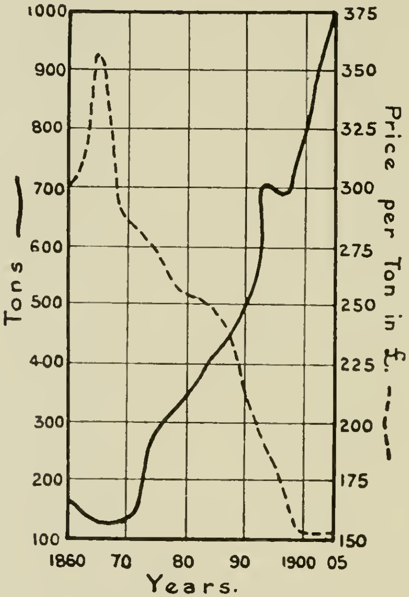

DIAGRAM XV*a*.—BOOKS PRINTED AND EXPORTED TO INDIA

On the Continent this material, for chemical and other reasons, was not much used, while our rag papers, because they always maintained their high standard of quality, were in slightly greater request at the hands of foreign and colonial consumers.

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[1] See Appendices I. and IV.

India [1] had always been an important market for our export trade, and, whereas in 1860 she only took 1,000 tons of our paper, twenty years later she received over 5,000 tons, equal to 15 per cent. of our total export (see Diagrams XV*a.* and XV*b.*).

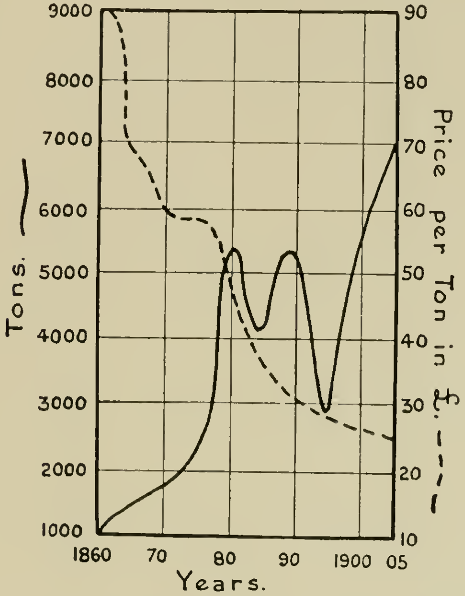

DIAGRAM XV*b.*—PAPER OF ALL SORTS EXPORTED TO INDIA FROM GREAT BRITAIN

Australia also had received large quantities from the mother country—an amount increasing from about 1,000 tons in 1860 to 9,000 tons in 1878. Since that date, owing to the competition of

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[1] See Appendix XI.

America and other Continental countries which have natural advantages of position, the Australian trade has been somewhat of a declining figure (see Diagram XVI.).

Since 1887 our exports have fluctuated considerably without showing any general advance. During the first few years of this period a steady decline was noticeable, the result of continued competition in paper produced from chemically treated wood pulp. This paper was very similar in appearance to that manufactured from esparto, and, though not really equal in quality, it was thoroughly serviceable for many purposes.

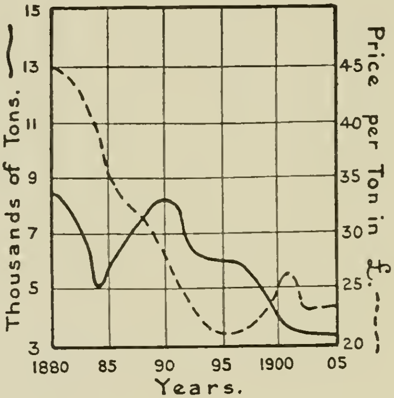

DIAGRAM XVI.—EXPORTS OF PRINTING PAPER TO AUSTRALIA

A slight advance was visible in 1896, but a drop again occurred for the next three years. From 1899 onward a welcome improvement has taken place, and this at the present time appears likely to continue.

While the total volume of our exports have no by any means increased in proportion to the amount of trade done in this country, new markets for our goods are constantly opening. Our exports to Germany (see Diagram XVII.), never a large quantity, improved about 90 per cent. between 1885 and 1900, and the decrease of the next two years may have been due to the feeling in Germany created by the Boer War.

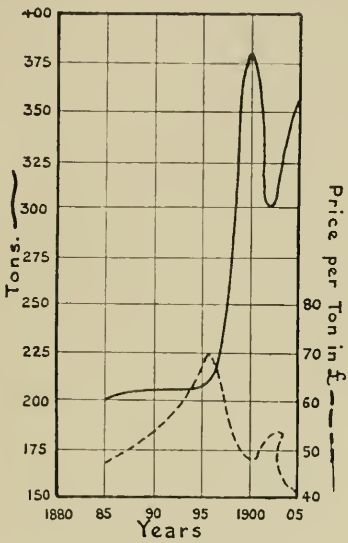

DIAGRAM XVII.—GERMANY

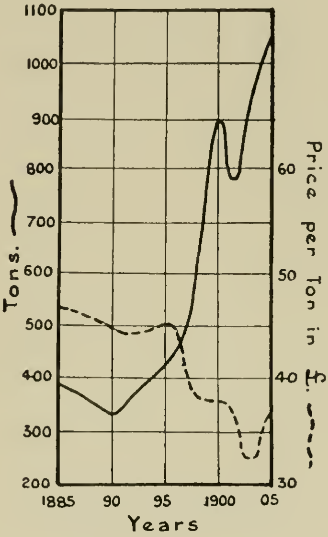

DIAGRAM XVIII.—BELGIUM

Belgium (see Diagram XVIII.) now takes 10,000 tons, where in 1885 she only received 4,000, and France (see Diagram XIV.) some 3,500 instead of one-seventh that amount.

China (see Diagram XIX.) has increased her consumption of English paper fivefold, and Japan (see Diagram XX.), until within three years ago, was taking 3,500 tons. To-day this has fallen to 2,000 tons.

South Africa (see Diagram XXI.) now takes 6,000 tons of English production, whereas twenty-five years ago the amount could be measured in hundreds. On the other hand, the continents of North and South America have proved an uncertain figure.

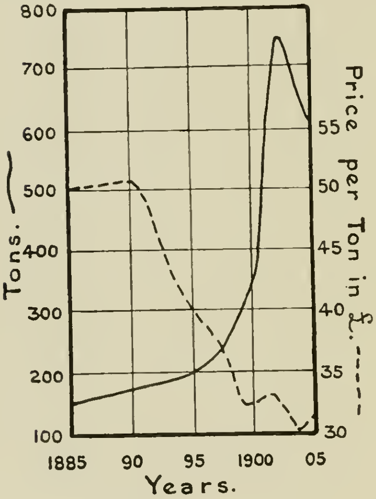

DIAGRAM XIX.—CHINA

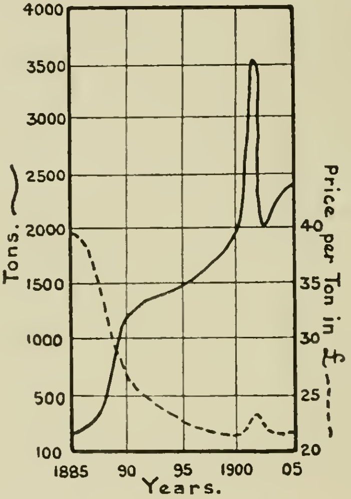

DIAGRAM XX.—JAPAN

The United States take but a trifling amount of paper from England—between 300 and 700 tons—and Canada, having plenty of her own raw material, uses to-day some 1,800 tons of the English paper. It is the expensive papers which find their way to these countries, for America and Canada make no paper by hand. (See Diagrams XXII. and XXIII.)

The English export trade of paper is neither likely to become large nor entirely to cease. It will for the most part consist of those expensive papers produced from the only raw material which the country possesses, and other qualities in which

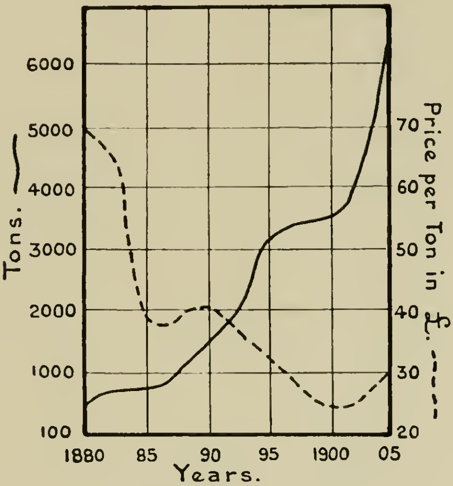

DIAGRAM XXI.—SOUTH AFRICA

English manufacturers have made themselves pre-eminent.

Up to twenty years ago not much manufactured paper was imported, for esparto and mechanical pulp were made into paper as easily in this country as at the source of supply.

But the advent of chemical pulp altered in a great degree this state of affairs, and, although a large quantity of this semi-manufactured article is still poured into this country, the diminished cost of making near the source of supply enables foreign paper to compete for the English market.

From 15,000 tons in 1889, the amount imported to-day is some 200,000 tons.[1] Germany, Norway, and Sweden have chiefly benefited by this enormous increase, and the price of paper has descended in proportionate scale.

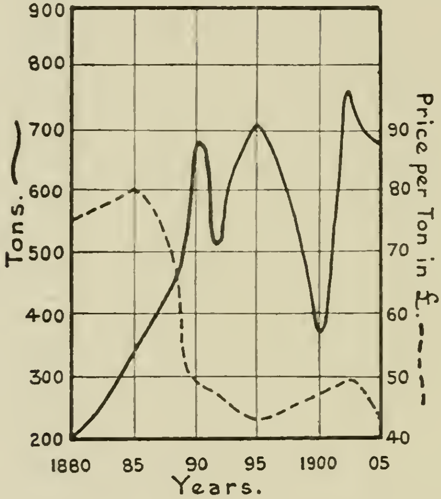

DIAGRAM XXII.—UNITED STATES AMERICA

Holland sends us a greatly growing supply of strawboard, and in general the consumers of paper have sympathised with the feeling in favour of free and unrestricted commerce.

But the paper-makers of this country themselves would, in perhaps the majority of cases, like to see the free import of foreign papers stopped, or at any rate restricted. At the same time the important feature of our foreign trade is that the British paper-maker is more and more engaged in making high-class and expensive goods for the rest of the world, whilst we buy a cheap and plentiful supply of fairly low-class papers in return.

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[1] See Appendices I. and II.

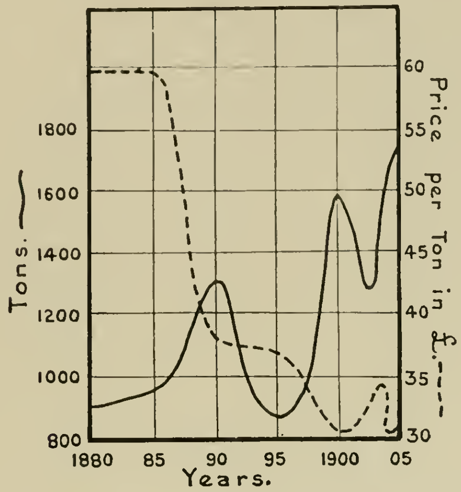

DIAGRAM XXIII.—BRITISH NORTH AMERICA

CHAPTER X

SOCIAL CONDITIONS

NO review of the history of paper manufacture would be complete which did not take some account of those general economic laws which have affected every industry in Great Britain. In this trade, as in all others, it is impossible to neglect the questions arising out of the supply of labour and capital. From scattered and scanty information we have to glean some idea of the number of hands engaged in the trade, the relative numbers of men and women employed, their conditions of work, their wages, and the general effect of trades unions and other industrial factors. We shall find, on the whole, that the conditions of labour have been good as compared with those existing in other industries. It must be remembered that the application of machinery to this manufacture has been comparatively recent. In the early part of last century, at the time of the greatest pressure upon human material, the bulk of the paper produced was still made by hand, and the skilled workers were in a position to make their own terms. It has been shown that so late as 1830 as much paper was made by hand as by machinery. By the time that the latter had increased and the total output of paper attained really large dimensions, public attention had already been called to the conditions of work in factories, Factory Acts had been passed, and trade unionism was becoming a force.

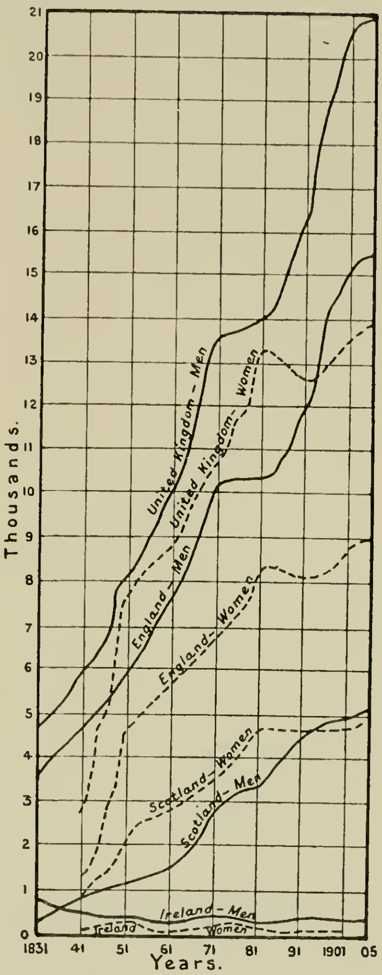

DIAGRAM XXIV.—PERSONS ENGAGED IN PAPER MANUFACTURE

We have already considered the dimensions of the trade so far as output is concerned. These may be gauged from another point of view by the number of hands employed. A steady increase in the numbers began at the end of the year 1830. In 1831[1] they counted in all some 4,800, at which figure they had probably remained constant during the first three decades of the century. It is true that during this earlier period the output of paper had almost doubled, but by 1831 half the output was made by machines requiring far less labour than the old hand methods.

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[1] See Diagram XXIV.

PERSONS ENGAGED IN PAPER MANUFACTURE

(*Compiled from Census Returns and Booth's "Occupations of the People.*")

	England.		Scotland.		Ireland.		United Kingdom.	
Year.	M	F	M	F	M	F	M	F
1801								
1811								
1821								
1831	3,700		400		700		4,800	
1841	4,600	1,300	700	800	500	200	5,800	2,300
1851	6,100	4,700	1,200	2,200	400	400	7,700	7,300
1861	7,800	5,600	1,600	2,800	300	100	9,700	8,500
1871	10,200	6,600	2,800	3,500	400	200	13,400	10,300
1881	10,300	8,300	3,400	4,600	200	300	13,900	13,200
1891	12,000	8,000	4,500	4,600	300	100	16,800	12,700
1901	15,400	8,900	5,000	4,700	300	200	20,700	13,800

With the firm establishment of machinery in the English mills women were at once introduced to the trade, and in 1851 formed 40 per cent. of the whole number engaged.

Between 1871 and 1881 the increase in the number of males is conspicuously small—a fact which may be accounted for by the large accession of women strength working in esparto mills and the introduction of wood-pulp, for which less male labour was required. Two opposite results arising from this importation may be noticed. The manufacture from wood-pulp, now imported in great quantities, enabled larger machines to be worked. The consequence was a greater output, and though the demand for men did increase this was not in proportion to the output, for the preparatory stages of news and common printing papers took place abroad, so that almost half the male labour in the mill was displaced.

The increase, therefore, of 15 per cent. in the number of men working in a mill must be attributed to the 40 per cent. growth in the production of paper, and would have been far larger if wood-pulp had needed a similar proportion of labour in this country to that required for rags. It will be seen from the table that the demand for women absolutely as well as relatively diminished, for this class of labour was restricted by the operation of the Factory Acts. During the last ten years of the century the necessity for female labour has again been felt, although the actual numbers have not increased with the same rapidity as in the case of men.

In Scotland the total increase has been in a similar ratio, but with the exception of the year 1901 the men have always been in the minority. This is accounted for by the fact that a greater proportion of the paper made in Scotland is of a good description, for the production of which female labour is better adapted.

Ireland has never contributed greatly to the manufacture of paper, and her number of workers was largest when the hand trade was predominant. The decline in Ireland is due chiefly to the absence of conditions making for steady, reliable, and efficient labour, and, in some degree, to the absence of coal for use in furnaces.

Throughout the whole of the United Kingdom the numbers of workers have continually but irregularly increased, although by no means in an equivalent ratio with the growth of paper-making as an industry.

To-day the largest number of people employed in one mill would be found in the factory of a maker of the best rag papers, and as many as 500 can be seen working for a weekly output of some 35 tons. In smaller mills, where the finishing process is not so elaborate, and only an ordinarily good writing paper wanted, 80 to 100 will be a sufficient number for making 20 tons. But where the greatest quantities are turned out per week—*e.g.*, 400 tons, chiefly from mechanical wood—the staff will often consist of 100 members.

The manufacture of paper from sulphite pulp requires about the same number of hands as there are tons produced per week, but abroad, where the wood itself is made into pulp and then into paper, three times the labour is engaged for the two processes.

To produce 100 tons of esparto paper 200 hands will be required. In a hand-made mill a staff of 64 will only produce 3 tons.

While moderate and gradual changes have taken place inside the mill as regards the number of employees, vast and important alterations have occurred in the condition of factory life. The introduction of machinery brought in its train many advantages to the general mass of the community, but not for a long time did it promote the social welfare of the poorer people. The enormous demand for labour created by the industrial revolution put workers almost completely at the mercy of their employers. Masters could let cottages at exorbitant rents. Hours were shortened for meals and lengthened for work. Truck was predominant in the rural districts. One universal shop was set up where every one was forced to deal, and where the food sold was as poor as it was costly. Many workers were never paid in coin for periods of several years.

But during the worst period of the industrial revolution paper was still being made for the most part by hand. When factories began to take the place of the vat mills, the conditions which applied in the latter to some extent modified the work in the factories with which they competed. As more and more machinery came to dominate the industry, the conditions of work were naturally more closely assimilated to those prevailing in the other great English factories. But by this time there had been a gradual improvement all through, and higher standards were demanded. Legislation had already made great changes ; hours and conditions of work were prescribed ; and trade unionism had become a force. But this last factor in the paper trade came from inherited traditions which began in the days of the vat mills and were handed on to workers in the factories.

For the first thirty years of the nineteenth century a regular standard of labour had been set in the hand-made industry, and the level then attained was never lowered. Wages, without ever being low, tended towards a slight increase. The Original Society of Paper-makers was founded in 1800. Its headquarters were at the Crays till the year 1815, when it was shifted to Maidstone, and in connection with this alteration an amusing incident arose. There was a determined effort to steal the books and papers belonging to the Union, and some prominent members had been deputed to fetch the box containing them to Maidstone. This they accomplished successfully, but when, after being unlocked, the box was opened, it was found to contain only a small quantity of worthless paper, while the documents belonging to the Society were afterwards ascertained to have been burnt.

An attempt to reduce wages had taken place in 1784 and 1797, but both were prevented by a successful strike—a fact which shows that before 1800 a rudimentary organisation already existed. It was on account of this attempt to cut wages and to stop the primitive system of apprenticing[1] that the Society was formally inaugurated in the hope of making combination effective.

In 1806 the employers did succeed in slightly lowering the wages of their hand-workers. But in 1815, when trade was brisker, provisions dearer, and the men called to mind the previous success, there was a strike in some parts of England which led to a return to the earlier wages.

In 1833, when machinery was forging ahead of the hand-made processes, a split within the Society occurred. The trouble commenced over the question of making two sheets on a mould instead of one as heretofore, two factions appeared, styling themselves "Stars" and "Deckles," and the matter was not finally settled until 1840.

Seven years later—a date at which the Society may perhaps be considered to have reached its zenith—the members were placed into three classes, according to the rate of wages. In the first class there were 320 men earning 22s. and upwards; in the second were 671 men in 114 mills, at wages from 17s. to 22s.; and in the third class were 54 men in 22 mills who received under 17s.

In 1848 the objects of the Society were for "the support of wages and customs, the resistance of oppression, the punishment of unprincipled and impudent men, and the relief of those who are seeking for employment."

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[1] Men often learnt their craft on the road, when calling at the mills.

From an unofficial inquiry into existing trade societies, made by the National Association for Promotion of Social Science in 1864, the following facts were obtained :—

Strikes which took place in consequence of a reduction of wages were supported by the Society. During the strike the allowance was 4s. per woman and 2s. a child until the men on whom they depended got work. Strikes were also occasionally supported when advances, especially requested, had been refused. Formerly it was necessary before striking to apply to the Central Committee in Kent, but this was not the practice at the date of the evidence given. There was never any act of violence, even though it was the custom for several mills to have more than one apprentice to a vat—a violation of an important Society rule. Only individuals ceased to work, and in no way did the members combine. No "general turn out" took place and no factory was laid still. A strike never occurred to force regulations on the makers regarding the conduct of trade; the regulations only affected wages. The action of working papermakers was uninfluenced by the combination laws, since they had had no knowledge either of their existence or repeal in general—a striking testimony to the moderation displayed by the Original Society throughout its existence.

In 1865 the employers allowed an advance of 4d. per day to the vat and machine mills belonging to the Society in Kent. This rise was considered to be necessary throughout the trade, and after the introduction of arbitration in 1874 a peaceful understanding was formed, impossible for years earlier. Mr. Kettle awarded the advance demanded in all departments of the vat mills, but nothing to the machine portion.

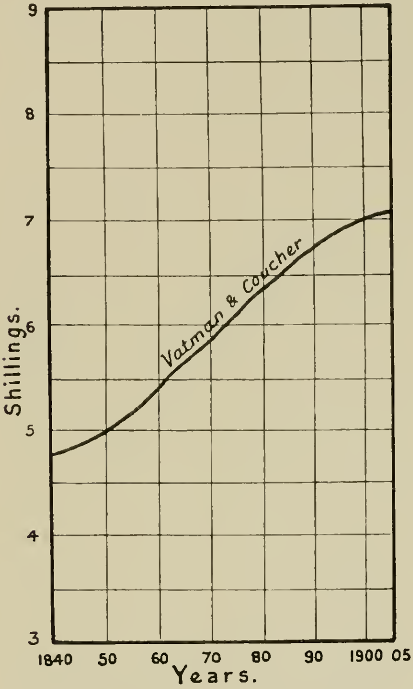

DIAGRAM XXV*a*.—ADVANCE IN WAGES

One or two other troubles have occurred since that date, but have been all gradually settled, and it is with pardonable pride that their secretary notes two facts—

"For over fifty years the workers have never had to submit to a reduction of wages, and no dispute has taken place with the employers, as a body, which has not been amicably arranged."

From 3s. 4d. a day in 1840 the vatman's wages

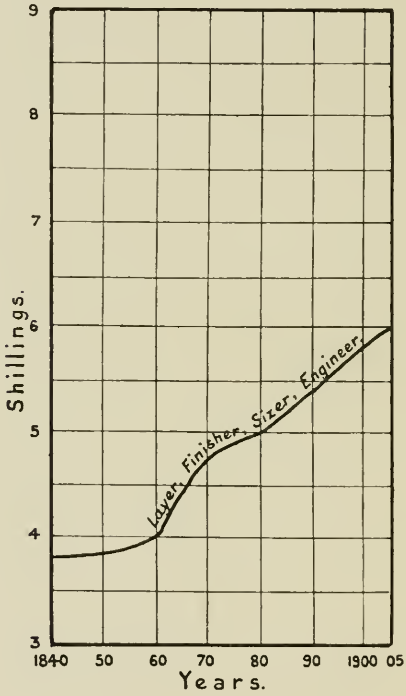

DIAGRAM XXV*b*.—ADVANCE IN WAGES

have been raised to 7s. and over, and the coucher in almost similar proportion, while although the layer and other workers have not secured so large a rise, their earnings have steadily grown. The

ADVANCE IN WAGES—HAND-MADE TRADE

	Vatman.		Coucher.		Layer.		Dry-worker.		Finisher.		Sizer.		Engineer.	
1840		4/7 Beer 2/- per wk.		4/5 2/- B.M.		3/9 2/- B.M.								
1851	Shire's wages 3/11. No Beer			Shire's Wages 3/9 No Beer		Shire's Wages 3/8 No Beer								
1853	4/7 Beer 2/- per wk.	7½% increase 4/11. Beer 2/- per wk.	4/5	4/9 2/- B.M.	3/9 2/- B.M.	3/10 2/- B.M.								
1863								3/10 2/- B.M.		4/1 2/- B.M.		4/1		4/4¼ 2/- B.M
1864	4/1	4d. daily extra wanted. Decision Post-poned.					3/10 2/- B.M.	4/2 2/- B.M.	4/1 2/- B.M.	4/5 2/- B.M.	4/1	4/5	4/4¼	4/8¼ 2/- B.M.
1865	4/11 2/- B.M.	5/3 2/- B.M.	4/9 2/- B.M.	4/2 2/- B.M.	3/10 2/- B.M.	4/2 2/- B.M.								
1866		Beer, 4d. per day's work.		Beer, 4d. per day's work.		Beer, 4d per day's work.								
1872	5/3 4d. a day B.M.	10% increase 5/9 4d. a day B.M.	5/- 4d. a day B.M.	5/7 4d. a day B.M.	4/2	4/8 Beer 4d. per day's work.								
1873	Men asked for increase of 6d. a day; this was not granted.													
1874	4d. day increase, but no rise to be asked for three years, then matter to come again before an arbitrator.						4/2	4/8	4/5	4/11	4/5	4/11	4/8¼	5/2½
1884	6/1	6/3	5/7	6/1	4/8	5/3 to *journey-men* layer.								
1890	Workman invited employers to acknowledge the justice of their claim to advance of wages by granting a voluntary rise. Employers did not respond and negotiations closed.													
1896	Workmen again ask for advance in wages. Bonus offered by one employer to section of workmen. Workmen request that all branches be considered; employers refuse. The question is left for a time.													
1898	6/3	6/5	6/1	6/3	5/3	5/4	4/8	5/4	4/11	5/7	4/11	5/7	5/2½	5/7
1903		From 6/11 to 9/6		From 6/9 to 9/4			5/4	5/7	5/7	5/10	5/7	5/10		

output is also undoubtedly steadier. In the old days men worked how and when they liked. They started at all manner of times in the night, sometimes not really commencing till Wednesday or Thursday, when some would work to the remainder of the week without rest. The men were not then so temperate as now, and it was no uncommon thing for a few to go on a drinking bout lasting three to four weeks. Both their character and physique have changed very considerably for the better, and would compare favourably with that of any body of mechanics. It is also generally admitted that there are few trades more monotonous to the worker than the production of hand-made papers, although in most instances the facilities for doing the work have so greatly improved that the work is not nearly so arduous or the hours so long as in the old days.

The present numbers of the Original Society compare, in the aggregate, unfavourably with other Trade Unions, and also with their record of 1847. At that date their membership was 1,045, including only those at work, and journeymen ; to-day they are about 600, with their 100 apprentices and 70 superannuated members. For the last ten years their numerical strength has been slightly on the increase, and it is probable that a *level* of members has now been obtained.

The brief History of the Original Society of Paper-makers only relates to the hand-made trade, or to the trade in mills where vats and machinery were both used.

The advent of machinery brought about a new state of affairs; and had it been possible for the Union then in operation to devote its attentions to the entire trade, the condition of workers between 1830 and 1850 might have been greatly different.

"At one time," according to the *Paper Trade Review*, A. S. Chapman, January 22, 1904, "every mill in England, Scotland, Ireland, and Wales was in membership with it, and the period of the Original Society's most widespread authority was the period of persecution of all labour organisations; the Trades Union then offered the one medium for all who hated and combated persecution"; while the *Papermaker and British Paper Trade Journal* writes: "For a period of twenty-five years after its foundation it wielded a power that was both feared and dreaded by the employers, who on many occasions had to submit to their works being idle for a long period during the existence of some dispute. Most of its members were journeymen both in the older and later sense of the term, as they only worked from day to day, seeming quite indifferent to continuing in permanent employment at one place, and frequently took long journeys in search of work in different parts of the country. But the identity of interest between vat and machine workers appears not to have been sufficiently strong to warrant increasing the scope of the Original Society's labours, and in 1853[1] the United

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[1] Since the separation of one section of their members the original Society of Papermakers determined to continue as before

Brotherhood commenced operations as the Union for Machine Workers. With one exception the founders of this Society were either ex-members of the Original Society or their relations, and during the first seven years of its work a general rise in wages occurred.[1] The machine men, instead of earning on the average 22s., took 27s. home at the end of the week, while the millwrights obtained 1s. rise. The finisher's earnings rose from 15s. to 18s., and the bleach-house man received some 2s. in excess of his customary allowance."

Both these references to the original Society show how lasting has been the memory of the influence which it possessed in the early part of the nineteenth century, but they also prove that for the new Society there was a greater and more interesting future.

Boys of fourteen who were also sons of members

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and devote their entire attention to the hand-made trade. Doubtless from their standpoint they were correct, for it is a perfectly distinct industry from the machine paper-making, and one which requires considerable experience and almost hereditary skill. At the same time, as has been said by one well qualified to know, "it was the ineffectual attempts on the part of the Union to restrain these machine mills, or to force their law for hand-made mills upon them, that kept the Society poor. There might still to-day be many more machine mills in the Union had they but recognised the impossibility of compelling them to work under the same laws as the vats or hand-made mills. It would have been far cheaper and better if they had from an early date severed their connection entirely with the machine-made trade and stood alone, as they stand almost to-day."

[1] See Appendix X.

were received as apprentices, and while either in that position or as journeymen (*i.e.*, the stage after the period of apprenticeship and before the age of twenty-one) they went on tramp during a period of unemployment. This system meant that a young fellow was given by the secretary at headquarters a tramping card, in which was shown a route all over the country and the names of all the public-houses in the towns and villages, and places where he could get accommodation for the night at half the usual rates. Should the morning happen to be a wet one, and the rain continue till 10 a.m., the landlord would then hand him a "wet day's turn," and he was allowed to stay for another twenty-four hours. On Saturday he received two days' pay, and remained there until the Monday morning.

The tramping route as arranged in the book would take a journeyman six weeks to cover, supposing he tramped every day and only rested on Sunday.

As this method of procedure continued for some years, it is not surprising that certain members of the United Brotherhood realised its degrading influences[1] on some decent men after they had completed one or two rounds of tramping. The objection took practical effect after a compromise had been found for the moment unworkable, and the modern Society of Papermakers was started in 1869. The immediate result was that the United Brotherhood discovered that, if they wished to maintain their position as a Trade Union, they must adopt the same methods, and by 1871 the tramping system had become almost a thing of the past.

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[1] The wandering period, originally intended as a method of training, had become the means of relieving the local labour market.

For twenty years these two Societies worked apart, but gradually they began to see that, if a possibility of uniting should occur, they would be in a much better position for securing an increase of wages and a reduction in the hours of labour, both considered at the time to be badly needed.

This combination was accomplished, and the Amalgamated Society of Paper-makers, open to skilled men only, issued its rules in 1894. Since that date the membership has grown from 708 to over 1,000, and a stronger and more capable Society has produced better and more lasting effects.

In 1890 the National Union of Paper-Mill Workers was established for all mill hands, skilled and unskilled alike. Prior to its formation there had been no Society for common labour in the trade, and even at the present time the amalgamated Society does not permit the entrance of machine and beater assistants.

As is but natural, both Societies have taken strong lines on the point at issue, and while one considers that the victory which it has so tardily gained after such strenuous conflict should not be easily shared, the other suggests that the difficulties which both classes of workers should have so vitally at heart will be more easily solved by a really united body.

From these remarks it can easily be seen that the want of co-operation among Trade Unions during the greater part of the nineteenth century has prevented the workers in paper-mills from obtaining as much benefit as might reasonably have been expected from internal organisation.

The tendency of legislation during the last century has been to take restrictions off in commerce, to put them on in industry. The Government interfered between employer and employee by Factory Acts, and the Law Courts by adverse decisions against Trade Unions.

In 1836 a Parliamentary Sub-committee sat to consider the state of paper-mills in Kent, Bucks, and Herts, these being taken as representative of the rest. It was reported that in a few of the establishments the sanitary conditions were not all that could be desired, and that in some the rags were very dirty and foul, and a hurricane blowing would fail to clear the abominably dense atmosphere of dust. Yet the only means of obtaining ventilation was by setting all the doors and windows open, so as to create a thorough draught, which would appear to be almost as injurious as the dust itself.

These remarks probably refer to an isolated instance, or else are rather exaggerated and misleading. It is possible that the dust, being heavy, readily settled; that the atmosphere was not much polluted, and the workpeople not as unhealthy as was suggested. This was certainly the view taken by the Committee, as the conditions were not considered bad enough for any definite recommendation.

The passing of the Act for the extension of the Factory Acts in 1867 was the first important improvement in the state of labour in paper-mills. It contained clear distinctions regarding employment :—

> 6. Male young persons of not less than sixteen years of age may be employed in paper-mills.
>
> 17. It shall be lawful to employ male young persons during the night, subject to the same intervals of rest which they are allowed during the day, and subject to this provision that no male young person employed during the night shall be employed during either the preceding or succeeding day, and that no male young person shall be employed more than 7 nights in one fortnight.
>
> 22. It shall be lawful for any male young person subject to the provision of this Act to work according to the accustomed hours of the trade ; provided,
>
> 1st. That the hours of work do not exceed sixty in any one week between midnight on Sunday night and midnight on the succeeding Saturday night.
>
> 2nd. That the hours of attendance at the Mill of any such young person shall not in any period of 24 hours exceed 14 hours, and in case the hours of attendance exceed 12 hours such young person shall be allowed half an hour for a meal in addition to the time allowed under the Factory Acts for meals.

A slight concession was made in Clause 5, that those mill-owners, who, at the time of the passing of the Act and for not less than a year previously, had been employing women and young persons at night and could not without a considerable interval of time alter the machinery, so as to dispense with such employment, might receive a special authorisation to work young persons and women for such times as had been previously customary, until the 1st of June, 1869.

The subsequent Acts between 1878 and 1891 defined more clearly the time necessary for meals, and that of 1901 was more explicit with regard to overtime employment. 1901—Section 5:—

> 1. If the process is in an incomplete state at the end of the period of employment of the woman, young person, or child they may on any day except Saturday, or any day substituted for Saturday,
>
> (*a*) be employed for a further period not exceeding thirty minutes;
>
> (*b*) provided that those further periods when added to the total employment of the woman, young person or child in that week do not raise that total above the number otherwise allowed under this Act.

More definite regulations were formed regarding the night employment of the male young person of fourteen, who could be employed during the night if in accordance with the following conditions, namely:—

> (1) He must not be employed on more than 7 nights in any 2 weeks provided that this condition shall not prevent the employment of male young persons in 3 shifts of not

more than 8 hours each, if there is an interval of 2 unemployed shifts between each 2 shifts of employment, and

(2) He must not be employed during the night in any process other than a process incidental to the business of the paper-mill.

It was universally expected that the Act of 1867 would do away with women-workers in paper-mills, because, as they were not allowed to work either on Sundays or overtime on weekdays, it was thought that their places would be taken by those who could work at these periods. However, the result has not borne out these anticipations.

Women have gradually ceased to do the kind of work they previously performed, but they have continued to be employed at other work, and, in spite of the fact that they are not needed where wood-pulp is used, they have steadily increased in numerical strength. Their labour consists either of picking out roots from esparto, rag-cutting on single-sheet rolls—in which case they feed the glazing machine very largely in salles, or paper sorting. The latter is the best class of work, and they earn from 15s. to 23s. per week, as compared with the lower wages of 12s. per week. Both these earnings have risen from 8s. in 1853.[1]

The shorter hours have, on the whole, meant better work, and in some mills, it is thought by the owners, that the tendency is towards a triple shift of eight hours for men—a *fait accompli* in some mills of the U.S.A., and in at least one large mill in

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[1] See Appendix X.

England. Of recent years the wages have been all paid on the piece-work system, and this has led to a greater earning power, the result of better attention and expertness.

A sharp distinction has at last been drawn between the work of men and of women, and the result has given entire satisfaction. The latter have not been displaced, and will continue to do their work so long as the arrangement is mutually beneficial to employer and employee—the work must be good, and the wages reasonable.

The conditions of labour have largely altered with the various raw materials brought into use in the making of paper. The surroundings of the men, with modern ideas of sanitation and health and higher remuneration, have doubtless improved the type; the hours of work have remained about 75 per week for the skilled and 60 for the unskilled, and the wages of all classes of labour have steadily increased. But the last point is difficult to gauge with accuracy, as it depends on many and complicated circumstances.

In Lancashire, where the demand for skilled labour is so great, and which is almost the largest centre for machine-made paper, wages have practically doubled during the last thirty or forty years.[1] Unskilled work is paid at the same rates as in other factories in the locality, and, in general, the wages of all other industries are regulated by the all-important and omnipotent cotton factories. Round

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[1] See Appendix X.

London, in Kent, Buckinghamshire, and Hertfordshire, wages have increased some 25 per cent. for skilled, and 50 per cent. for unskilled labour. In Devonshire and Wales, where the cost of living is cheap, wages have always been low, and their rise has been more gradual than in other districts. Scottish mill owners have not increased their wages very largely during the last twenty years, except in the North of Scotland, where, since 1895, there has been an immense advance; while in Ireland, although the wages have always been rather lower than in England, the increase has been in a similar proportion. Wages in a mill for printing papers, especially where the tonnage system is in vogue, and the output greater, and the conditions more trying, are, as a rule, larger than the amount paid in a mill making writing papers.

The general improvement in the social and educational status of the country has naturally been followed by an increase in the wages.[1]

In 1893, before a Royal Commission on Labour, Mr. Ross, the General Secretary of "The National Trades Union," said he considered the unskilled men were badly paid in comparison with the hours they worked. Only the few who had the practical driving of the mill got the tonnage bounty.

The classification of men-workers in a mill is not very complicated. First of all, in the case of paper made from rags, there are the men who supervise the rag dusting and the conveying of it from the devils to the boiler. Secondly, there are the boilermen, into whose hands the material next passes. Both these sets of workers are under the same head foreman. Thirdly, the breakermen and beatermen and their subordinates have charge of the breaking and beating respectively; and lastly, there are the machine-men, whose operations start from the stuff chest and finish with the calendars and dryers. In an esparto mill there will be no beater or breakermen; their place will be taken by a man who looks after the potcher—a similar vessel to the breaker, but of larger dimensions.

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[1] See Appendix X.

Those employed during the day one week work at night the next six days; for under modern conditions, in which quantity of output is the main consideration, it has been found impossible to dispense with night work. The usual working hours are from 12 o'clock midnight on Sunday till 2 p.m. the following Saturday. During that period the mill machines are continually running. At one time it was customary to continue up till 12 p.m. on Saturday. But this is seldom done to-day, except under extreme pressure of work, in which case a special rate of overtime is paid for the extra six hours. When the improvement was made the wages were not reduced. Thus a half-holiday was granted without loss of wage to the employee.

In other respects the sanitary and social conditions have been immensely improved, and healthier conditions established, by the provision of suitable dining-rooms and lavatories. In the rag-dusting and cleansing operations efficient dust-extractors have been fitted to keep the air free from dust, and in the finished paper-sorting departments steam pipes have been placed to warm the room during cold weather. The modern buildings are lofty and well ventilated, and exhaust fans are used to draw out the steam from the paper-machine houses. Heavy labour is reduced as far as possible by the adoption of travelling cranes and similar appliances; in general, a system of comfort predominates in the paper-mill of the twentieth century.

One point has been only touched upon in this brief account of labour in the paper trade, but it is of great importance, and may fittingly conclude this chapter, as it will be of the utmost importance in the future of the industry.

The rules and customs regulating the number of apprentices have always been an important if somewhat thorny point between the Union and the employees, and doubtless they were productive of many disputes and the entire loss of many mills to the Society. One apprentice is allowed to each vat at work, and in machine mills connected with the O.S.P. one to each machine, or one to every seven men employed. In the case of vat mills, it averages one to every four men; and in the latter, should a fresh vat start, it must be kept running continuously six months before the boy is recognised as a "legal apprentice." A succession of generations may frequently be noticed, the same names occurring in the Society's books as could be seen a century ago, son following father as generation after generation passed by; and it has been no very uncommon thing to see the names of seven or eight members of one family working at one mill. There is undoubtedly a good deal of truth in the saying that a paper-maker is born not made; and it would be surprising to the uninitiated to see how quickly some learn their trade, whilst others with the same advantages drag through the whole seven years with only an indifferent knowledge of their trade. It is, no doubt, the same in other trades, and it is to be regretted that this second class of individuals become a burden to their Societies and a drug on the labour market. There is one thing, however, which may happen to a paper-maker, which could hardly be possible in any other calling. He may lose his shake; *i.e.*, if a man is a vatman used to making paper by hand every day, suddenly, and without being able to give any explanation himself, he is unable to make the paper as he has done before. Unfortunately, he may never recover his shake, or when once afflicted, be liable again to lose it at any time—a serious thing when not efficient in any other branch.

Whether the regulations for taking apprentices have been for the welfare of the trade as a whole is an open question, but in the case of the hand-made industry, they have undoubtedly drawn together employees and employers. But few of the machine mills have been accustomed to take apprentices. Fifty years ago boys in mills were generally the sons of workmen in the mill, and they commenced as assistants in various parts of the building. In all probability the sons of machine men would commence as back tenters in the machine-room ; they would act in this capacity for some three or four years, and then, as vacancies occurred, would become drymen or cuttermen, and finally fill their father's position. A beaterman's son would follow a somewhat similar course ; commencing as an assistant in the beating-room he would in time become a breakerman, and finally a full-grown beaterman. With the foreman and finisher the same course of promotion applied. Their sons would commence in the salle, counting and folding the paper, and in their turn would become finishers. To-day the same practice holds in some places. The boys, whilst not apprenticed, work under the care of their fathers, who are naturally anxious to make them efficient and get them on in life. But, speaking generally, we may say that the apprentice system, so far as machine-made mills are concerned, has been dead for many years. It is the usual practice to allow boys who show any capabilities to advance from one department to another as vacancies occur.

But the important point is that where a definite system of apprenticeship previously existed, there is now no definite system which takes its place. Technical instruction is needed to give the boy a fair start in his entry on modern industrial life.

Mr. Ross, the Secretary of the National Union of Paper-Mill Workers, writes that :—

> "As a Society, and as members individually, we are thoroughly aware of the value of a good technical as well as a practical knowledge of paper-making. We find, however, that in some mills, the young men who show any particular desire to acquire and apply technical knowledge to their work, are not looked upon with much favour by their foreman. These rely on the old rule-of-thumb methods, and are jealous of those who wish to be more up to date. Such drawbacks have been pointed out to employers, and where the double-shift system was once all against the chances of shift workers attending classes, a remedy has been found in holding these on Saturday afternoons."

Mr. Dyson, of the Amalgamated Society, writes :—

> "That our members fully recognise the necessity of technical education, and let their sons avail themselves of it whenever an opportunity occurs, qualify them for positions as foremen and managers."

As is natural, Societies will do their best for the boys when they have persuaded them to become members. What is most of all needed is that employer and Trade Union should combine and see that by some means the boy receives a thorough technical education. He will then take a greater pride in his work and perform it with more efficiency.

APPENDIX A

THE GEOGRAPHY OF THE BRITISH PAPER TRADE

THREE districts in the United Kingdom have always formed important centres of the paper trade: Kent, Bucks, and Herts, from their proximity to London; Lancashire, with Manchester as its market; and Lothian, having Edinburgh as the chief town for distribution. From these places, as well as from Devonshire, Wales, and Ireland, a considerable amount of present and past information has been obtained—sufficient at any rate to estimate in some degree the local importance of the trade.

In the county of Kent[1] there has been no more prominent firm than that of Edward Lloyd, Ltd., and although in 1861 two machines were erected at Bow on the river Lea, the actual centre of his paper-making soon came to be at Sittingbourne.

Here the first really wide machine was erected, 123 inches on the wire. It was the forerunner of wide machines and quick speeds. When the supply of rags was dropping below the demand, Edward Lloyd perceived the value of esparto and, to avoid further troubles on that score, acquired properties in Algeria and the south of Spain, secured from the authorities the right to collect the grass over large tracts of land, and put himself into an independent position. At the same time he experimented with and used the leaves of the dwarf palm from North Africa, and there is not a known fibre which has not been put to the test at his mills. He recognised the value of wood-pulp, and, in fact, was among the first to use it in this country.

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[1] See Map, p. 175.

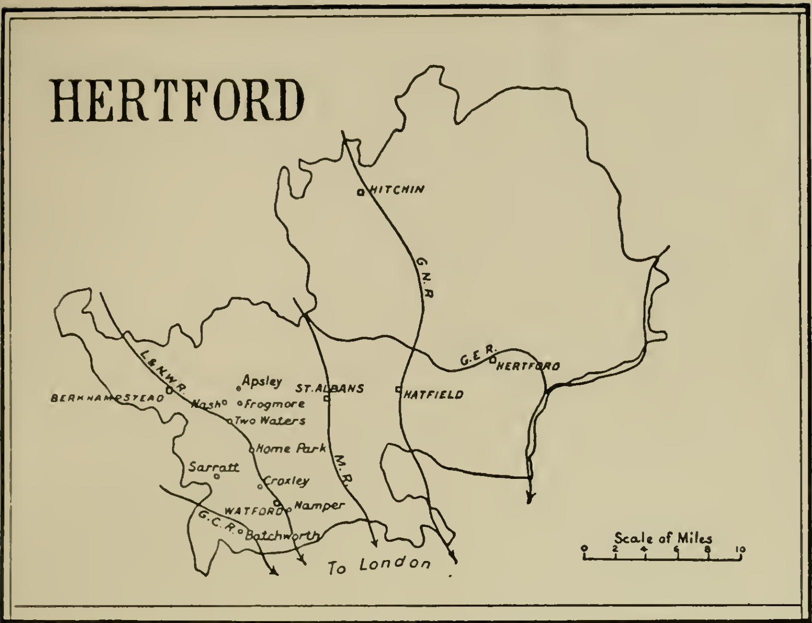
Sittingbourne was an ideal site for a mill, placed as it is on the greatest waterway in the world, and not far from the offices of his newspapers.

By 1877, what is now known as the Old Mill, was running on 50 tons a week; twenty years later the weekly output had been increased to 450 tons, 120 of which were shipped to the Colonies and India.

During this period, however (in 1891), the New Mill had been added, and that, with its seven huge paper-making machines, is turning out 530 tons, making an aggregate at Sittingbourne of some 1,000 tons per week.

For the production of wood-pulp to supply their English mills, a pulp-mill was purchased at Honefos, in Norway, and this was from time to time enlarged.

The history of certain paper-mills in the district near Maidstone is full of interest. Some of them were formerly engaged in cloth-making, and when


HERTFORD
HITCHIN
G.N.R.
G.E.R.
HERTFORD
L.&N.W.R.
BERKHAMPSTEAD
Apsley
ST. ALBANS
HATFIELD
Nash
Frogmore
Two Waters
Home Park
M.R.
Sarratt
Croxley
Hamper
WATFORD
G.C.R.
Batchworth
To London
Scale of Miles
0
2
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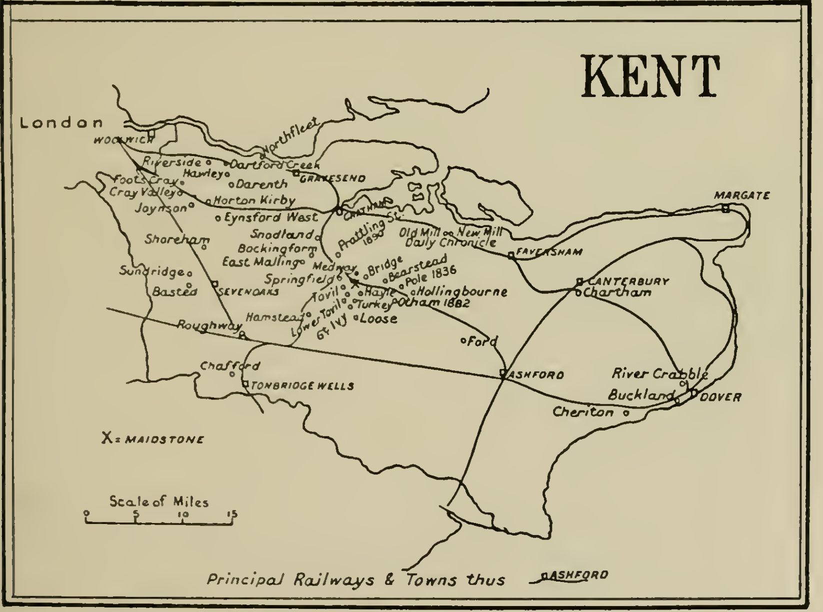
KENT
London
WOOLWICH
Northfleet
Riverside
Dartford Creek
Hawley
GRAVESEND
Foots Cray
Cray Valley
Darenth
Horton Kirby
Joynson
Eynsford West
CHATHAM
MARGATE
Prattling St. 1890
Old Mill
New Mill
Daily Chronicle
Snodland
Shoreham
Bockingford
FAVERSHAM
East Malling
Medway
Bridge
Bearstead
Pole 1836
Sundridge
Springfield
Basted
SEVENOAKS
Tovil
Hayle
Hollingbourne
CANTERBURY
Chartham
Lower Tovil
Turkey
Otham 1882
Hamstead
Gt. Ivy
Loose
Roughway
Ford
Chafford
TONBRIDGE WELLS
ASHFORD
River Crabble
Buckland
DOVER
Cheriton
X = MAIDSTONE
Scale of Miles
0
5
10
15
Principal Railways & Towns thus ASHFORD

the cloth trade died out it was succeeded by paper-making, which has since become one of the leading trades of the district.

In 1719 the first paper-mills on the river Lea were converted from Fulling Mills. One of these made white, the other brown papers; both belonged to a William Gill, of an old Boxley family, who sold them in 1731 to James Whatman and W. Brookes. Eight years later James Whatman was the sole owner, and he rebuilt and called them the Turkey Mills—a name derived from the old Fulling cloth mill, which made a peculiar kind of red cloth, called Turkey red.[1]

In 1786 a paper-mill was erected on the site of a corn-mill, at Padsole, on the Lea, by J. Smythe and Finch Hollingworth, and in a short time Thomas and Robert Hollingworth took the place of the first of the original two owners.

The three Hollingworths further purchased from James Whatman, Turkey Mills and also the Pole Mill, situated in a hollow a few hundred yards up the Lea.

In 1824 Thomas Hollingworth, the last of the three, died, and was succeeded by his two sons. About 1830 their property consisted of Turkey Mill, 9 vats; Padsole Mill, 6 vats; Pole Mill, 2 vats; Upper and Lower Loose, 2 vats each;[2]

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[1] *Kent Messenger*, 1901.

[2] The Loose Mills, only used for making half-stuff, were changed into flour mills between 1860 and 1870. Pole Mill was pulled down and done away with about 1836, and the ground thrown

Hollingbourne Mill, 5 vats; and Otham, 6 vats. Of these the last-mentioned was the first to possess a machine. Introduced about 1834, the machine was later on taken out and put into Turkey Mill. The Otham Mill was used for making half-stuff, and has now been idle for twenty years or more. For a long time the Hollingbourne Mill was used in making paper for the Official Register of Births, Deaths, and Marriages. It is now still standing as a flour mill on the right-hand side of the Ashford road, on the Lea, between Maidstone and Hollingbourne.

In 1846 No. 1 machine was put up at Turkey, coincident with the building of the shaft and the putting in of the first steam engine. Previously the mill had been driven by water; to-day there are six steam boilers, five continually at work.

On November 14, 1848, the vats at Turkey were abandoned; and ten years later a second machine was added. The third was removed from Otham to Turkey.

Writings, book and drawing papers, were all made at Turkey Mill from 1860 onwards, and from 1870 superfine and ledgers were added to their output. The quality has always been of the best, and the original Turkey Mill watermark is a guarantee for all that is good in paper. The

into Lord Romney's Park; while Padsole Mill, in which such excellent papers were made a century ago, was taken over in 1840 by a firm for producing paper from a new fibre. This venture was unsuccessful, and it is now a flour mill.

Turkey hand-made business went to Springfield Mill, near Maidstone. The number of vats have increased from twelve in 1860 to sixteen in 1880, and at present number eighteen. The qualities made are the well-known Whatman drawing, writing, and account-book papers, and the proprietors, Messrs. W. & R. Balston, now employ nearly 1,200 hands.

The Tovil Mills, both Upper and Lower, are well known in the Kent paper industry, and have gone through many changes. Of the early history of the Upper Tovil little is now known, but up to the fifties hand-made papers only were manufactured. These were worked by people of the name of Rose & Turner, and afterwards by a man named Giles. There were three or four vats, and he ran the mills with men outside the Union, with the result that there were frequent disturbances, and the mill was broken into at night and the paper thrown about. On changing into the hands of W. Simpson, one small Foudrinier machine was put in, and a second added a few years later, after another alteration in proprietorship had occurred.

Prior to 1872 it was worked by Simpson & Hargreaves, and the main production was in news, made from straw. The mill then came into the hands of Bankers, and about 1878 was taken over by the Tovil Paper Co., Ltd., and worked by them until 1896, when a portion of the works was destroyed by fire. During the time of the Tovil Company extensive additions and alterations were made to the mill, but after the fire had taken place they did not consider the past working sufficient to justify rebuilding.

The mill was lying idle until it was taken over by Messrs. A. E. Reed & Co. in 1896. It was then thoroughly overhauled and fitted with modern machinery, to meet the present requirements of the trade ; the parts destroyed by fire were rebuilt, and extensive alterations in the arrangements were effected, specially with a view to raise the quality of the product. Although the mill is in some respects old-fashioned, yet it is fortunate in having an ample supply of water, and energetic proprietors have been able to secure for their makes of imitation parchment, mill-finished and sup. cal. printings, a good reputation throughout the trade.

The Lower Tovil Mills were in the possession of Mr. Peter Musgrave about 1735, and then passed into the hands of Henry Allnutt. There is said to have been a fire at the mills in 1819, and about 1830 a machine was put in, and by 1842 a second had been added. For some time previous to this both vats and machines were working together, and a number of fine qualities were made, particularly coloured paper in great variety. Machine-made crayon paper was made here in 1848, and paper sized with rosin. With the introduction of the second machine, the vat trade passed away, and in addition to the different qualities already mentioned, drawing and chart papers were made between 1860 and 1870, printing royals and antiques after 1880, and to-day all qualities of good class writing and printing papers.

For many years the Ivy Mills were also under Messrs. Allnutt & Sons, who had been taken into partnership by Mr. Smith, once partner of the original owner, Mr. Robert Pine. For many years it continued under Mr. Allnutt, and was eventually sold to Mr. J. Barcham Green, owner of Hayle Mill, but continues to be still known by its previous name. One machine and one vat turned out drawing, coloured, plate, crayon, and hand-made papers, but about 1884 Mr. Lawrence Green, finding it not so convenient as Lower Tovil Mill, moved the whole of his business there, and Ivy Mill stood empty for several years. In 1890 it was taken by the Ivy Millboard Co., the present occupiers, and they produce machine-made millboard and portmanteau boards.

The Hayle Mill, situated in the valley of the Loose—so called on account of the stream passing underground and disappearing for some distance—is, and always has been, a hand-made mill. All the mills in this valley were old-established, and Hayle, the last to be built, was founded in 1806 by a John Pine, a member of an old-established family. Originally possessing vats, it was sold, in 1811, to the great-uncle of the present owner, John Green, who carried on the mill till 1839, when he sold the business to his brother, Samuel Green, and it has remained since then in the possession of his descendants.

Three extra vats were introduced, as the work of the mill gradually increased, and all qualities of hand-made paper have been produced.

Medway Mill was originally in the hands of some people of the name of Macey and Ives, interested in shipping, and browns and packing papers were manufactured. About 1805 they dissolved partnership; the mill came into the market, and was sold by auction to the late Walter Monckton, who converted it into the Medway Paper Co., Ltd. On account of the smoke nuisance, W. and R. Balston brought an action against them, and they were finally successful in getting an injunction, which stopped the mill.

It was then bought by Balston, who put in five vats, making twenty-two in all. Machine-dried browns, cartridges, and royal hand were the leading papers for some time turned out by this mill, but when it came into the possession of the present owners, best qualities of writings were made as at their other mill, Springfield.

Ford Mill, situated at Little Chart, fifteen miles from Maidstone, was originally in the hands of George Langley, who made large quantities of ammunition paper. In 1862 it was taken over by Waterlow & Sons, who, some ten years later, sold it to Batchelor & Sons. The number of vats has increased from two to four, and the ordinary qualities of hand-made paper have been made.

The Eynsford Paper Mills were started 120 years ago, and for more than one hundred years vats only were worked. The location was chosen for the water power, and rags have been the only raw material used. In 1895 a mould machine was put in to produce best account-book, loans, bank-notes, and the celebrated "Unbleached Arnold Papers" are still being made. During the last seven years large alterations and additions have taken place in improving the home-made article.

It is generally believed that the valley of the Darenth, where this mill is situated, was the original home of the paper-making industry, started by the Huguenots at the time of their expulsion from France. The reason for this assumption is that there were many small rivers of pure water available for power and paper-making purposes, and although the tradition is perhaps not absolutely sound, it has always been believed in throughout the country.

Machines were put into the East Malling Mill in 1847, when taken over by Messrs. Busbridge & Co. from Tarrell & Smith, who failed. There were two mills, the upper and the lower, and a waterfall at each guided the choice for location. The former was rebuilt in 1788, and for many years turned out hand-made writing papers; in 1820 Browns were being made by the lower mill. Writing, drawing, and account-book papers have been manufactured, and the number of machines, viz., two, have not been increased since 1870.

The Basted Paper Mills, near Sevenoaks, have been in existence for over one hundred years, and for a long period turned out nothing but hand-made paper. About 1836 the first machine was introduced, and since that date the very best papers of this description have been made. Rags are the only raw material that have ever been used, and a good supply of water has always been one of the mill's chief assets. Machinery has been added and altered from time to time, and the output gradually increased.

One of the most important mills in the county is Buckland Paper Mills, Dover, now belonging to Wiggins, Teape & Co., Ltd., and was in existence some time previous to 1800, while machines were introduced at a very early date in the nineteenth century. Rags have always been the raw material used, but the quality of paper made has undergone distinct changes. In the first half of the last century, royal hands and paper of that class were produced; between 1850 and 1880, tub-sized stationery and office papers; since the latter of those dates high-class banks, writings, and ledgers. A pure water supply and fair power had probably more to do with the choice of situation than the coal supply. Many alterations in the character and ownership of the Mill have taken place. It was owned in 1800 or thereabouts by a Thomas Horn, was burnt down in 1814, and rebuilt some time after this. It then passed into the hands of Mr. Charles Dickinson, and subsequently into the hands of Mr. Weatherley, a relation of the Mr. Weatherley who was at the time the proprietor of Chartham Mill. Sold to Mr. Charles Ashdown in 1849, Buckland Mill was carried on by him until 1879. It then passed to the hands of his son, who was joined by Mr. Hobday, and they carried it on until 1890, when it was sold to the present owners. Ashdown & Hobday had greatly enlarged the mill, and after its destruction by fire in 1877 the new buildings were erected on a larger and more modern scale. Messrs. Wiggins, Teape & Co. have added another machine, and further extended its possibilities.

Crabble Paper Mill has been bought and used as a rag-cutting and boiling house, and it is of interest that this mill, older than Buckland, was almost the first machine mill in Kent.

River Mill, near Dover, was also standing over one hundred years ago. Originally it was a vat mill, and before machines were commenced hemp and manilla were worked, and the paper made was loft air-dried browns. For the last forty-five years it has had two machines, and been in the hands of its present owners, Messrs. F. Phipps & Co.

The date of the foundation of Chartham Mills, near Canterbury, is uncertain, but it was running as a two-vat mill from 1830 to 1840, and turning out about 1 ton per week of good-class paper. Owned by the Dean and Chapter of Canterbury, and leased by W. Weatherley, a machine was put in by Bryan Donkin in 1840. About 5 tons of book paper were made per week, but in 1851 the mill was burnt down, and after being rebuilt was again destroyed six years later. After the second fire the Mill was entirely remodelled by Bryan

Donkin, a turbine put in, more steam power added, the bed of the river lowered to give more fall, and a fine drier built. About 1860 it commenced running again, and was soon making 8 and 10 tons of writing and account-book papers weekly. From about 1870 to 1880 a considerable number of Government orders were taken, and the mill turned out, at times, as much as 20 tons per week. For a short time esparto was used as a supplement to rags, which had always been the material worked. After the Government orders fell off a connection was built up on account-book, best writings, painting and drawing papers, and the mill has been run on these lines since about 1885.

A mill of historical interest, and one on which the progress of time has had less effect than in the majority of cases, is that belonging to Messrs. Turner, Ltd., known as the Chafford Mills, in the Tunbridge Wells district. 1746 is the date given of its birth, and good spring water and its position on the river were probably the chief factors in the choice of location. A machine was added to the vats in 1820 and another in 1846. Superfine writings, best copyings and tissues, have been the leading qualities of paper made, and, owing to the fact that they have been similar to the hand-made papers, and produced under the old style, the alterations in the mill have been conspicuous by their absence.

Horton Kirby Mill, near South Darenth belonged in the early days of machine-made paper to a man by name of Hall, a relation of Halls, the engineers of Dartford, where Bryan Donkin was originally employed. A machine was put in, and high class papers made, which for some time competed with Joynson's output. Messrs. Spalding & Hodge afterwards occupied these mills, and were one of the first to treat esparto. Some sixteen to twenty years ago, the mills were purchased by the Fitz-Georges and the Duke of Cambridge. Paper was made for such publications as the *Graphic* and *Commerce*, but a failure occurred, and the mills were finally purchased by A. E. Reed & Co. Esparto papers are still produced, and in addition a coating machine has been erected, and the general plant much improved and brought up to date.

The majority of Kentish mills have a long history behind them; they have witnessed the change from vat to machine, and in many cases preserved the memory of the past by retaining plant necessary for the hand-made process. Rags have been the chief raw material, a comparatively expensive paper made, and, with few exceptions, wood-pulp fast-running machines have not been connected with this county. The Northfleet Mills have, however, only been in operation for nineteen years. When the mills were started, two large paper machines were put down. In 1891 an additional machine was introduced, and another in 1893, so that at the present time they are running four machines. Up to three years ago pulp and wood were being imported to work under the sulphite process, and the owners, the Ekman Pulp & Paper Co., Ltd., form one of the pioneers in this important branch of the paper-making industry.

The Paper Mills at Snodland, belonging to C. T. Hook & Co., had, in 1905, five machines running, whereas in 1870 they only had three, and made a large variety of lower-class paper, from the cheapest "news" to the medium quality esparto printing. In August of last year the whole mill was destroyed by fire.

In conclusion, no account of the Kentish paper trade could be given without some reference to the famous mills at St. Mary Cray belonging to Messrs. W. Joynson & Son, where some of the most important discoveries and developments in the history of paper-making have taken place.

William Joynson, the founder, came from High Wycombe, the very heart of a district swarming with paper-makers, and took the mills at St. Mary Cray, which were previously in the possession of a man named Barratt. Mr. Joynson, in conjunction with Barratt, changed these mills from producing hand-made into machine-made paper, by putting in one of the first paper machines about 1828. These mills are generally credited to be the first to watermark machine-made paper, and rolls were produced by a new process with a great degree of accuracy, and with the result that the surface glazing of paper was much improved. The mills were formerly in the hands of Union men who, at that time, dictated to their masters. On the introduction of machines, the Union men were discharged, non-Union men substituted, and the mill struck off the list of the Original Society of Paper-makers in 1830. In the report of the Jurors (Exhibition of 1851), it was stated, as evidence of the progress of paper-making up to that time, "Fine writing paper is now made, sized with gelatine, dried and cut into sheets at the rate of 60 feet a minute, in length, and 70 inches in width, at the works of Mr. William Joynson at St. Mary Cray, Kent, which produces, from only two machines, the large quantity of 20 tons per week."

To-day the progress has been made in quality and variety more than in quantity. There are some 500 men and women employed, there are still two machines, and the output varies from 35 to 50 tons per week.

Buckinghamshire[1] has always been an important county in the paper industry, and the mills situated around Bourne End are numerous as well as interesting. The Lower Mills were probably in existence at the beginning of the century; their first owner was a Mrs. Angel, and hand-made papers were introduced. It then came into the hands of Mr. Morley, who put in a machine, and is believed to have worked at a loss for some fifteen or twenty years. From Mr. Morley it passed into the hands of Mr. Chadwick, who failed; then to the hands of

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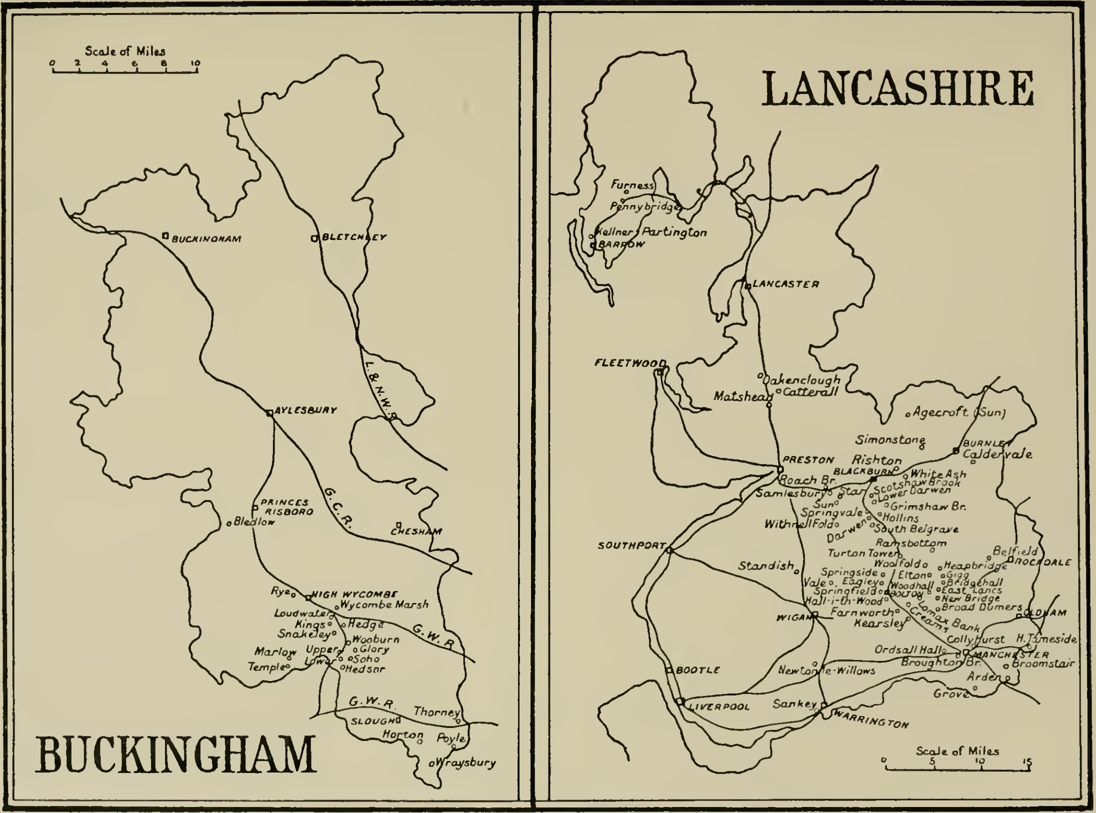
[1] See Map, p. 189.



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the Buckinghamshire Millboard Co., which also failed; after this it was dismantled.

Jackson Upper and Lower Mills, the former identical with Prince's Mill, and the latter known as Ganford Mills, were both originally rag mills. The date of their formation is uncertain, and they have been used for various manufactures, from gunpowder to millboards, and many vats and machines have been at work at different times.

Hedsor Mills were started in the year 1752. Originally a paper-mill, it was only used for making boards, and the machine for this purpose was introduced in 1888. The materials now used consist of rope, hemp, brown and other waste papers, and all classes of millboard are manufactured. The choice of situation was probably the water-power available and the proximity to London, and to the fact that with several mills together it would be easier to obtain labour of the type required, and travellers could pass from one mill to another, the grouping of a few mills in the same district may be attributed.

Marlow Mills were purchased by the ancestors of the present proprietors, Messrs. W. Wright & Sons, in 1780. According to old deeds they were oil and thimble mills, and were at once converted into paper-mills. Machines were started in 1810, and one of them was the third machine erected in this country by Fourdrinier. Cotton was treated principally up to 1840, and ammunition paper was made. Since that date hemp and jute have been the raw materials; small hands, bag and brown caps—the finished article produced.

The mills are now running very much on the old lines, with undershot water wheels, although a turbine wheel has lately been introduced.

The Temple Mills, Marlow, were originally built for copper rolling about two hundred years ago. From 1847 till 1866 it was worked as a paper-mill by Weedon & Sons. Only machine-made paper was produced, and white printings from rags was the leading quality. Closed for seven years, it was restarted by Messrs. Thomas Bros. & Co., Ltd., with two machines in 1873. Bagging and ropes were the raw materials worked, and brown paper made.

High Wycombe and Loudwater are other important paper-mill centres in Bucks, for the river Wye gives the needful water power, and the spring water is pure and adapted for the manufacture. Of those in existence at the present time, perhaps Wycombe Marsh is the most interesting. In a history of Bucks, in the Free Library, Wycombe, there is a paragraph relating to the transfer of a title-deed, where, amongst other property, there is mentioned "also the mill at Wycombe Marsh." This was in the year 1194, and was supposed to refer to the present Marsh Mill, which was probably a corn mill. In the latter end of the eighteenth century it was transformed into a vat mill by a man named Bates. He was succeeded by one named Hayes, and in the early part of the nineteenth century the mill came into the hands of the Venables family. They owned several other mills in the district, and Charles Venables was the resident at Marsh Mill. During their proprietorship a machine was introduced, and in the year 1831 the workmen (called "carded men") of all the mills in the district, fearing that their trade was in danger of being superseded by the machines, held a secret meeting in the woods between Flackwell Heath and Loudwater. A resolution was passed condemning the machines, and each of the men was sworn to do his part in breaking up all the machines in the valley. They proceeded in a body and effected an entrance into some of the mills, doing considerable damage, but were finally stopped by an army of specially appointed constables. Some of the mills had heard of what was proceeding, and were well defended; and an incident is told of a man losing the sight of one eye. He was about to blow the lock off a mill door with gunpowder, and before doing so he was making an inspection of same by placing his eye to the keyhole, when some one on the alert ran a red-hot wire through. This not only cost the man his sight, but served as a means of identification, and he, with several others, were tried and condemned to various terms of imprisonment. About 1850 the mill passed into the hands of the Wheeler family; twelve years later it was burnt to the ground, and then rebuilt, and has remained in the same condition until it was taken over by A. E. Reed & Co.

in 1898. Rag was originally the raw material worked, but plant was installed for esparto in 1862. To-day its paper is practically all made from wood-pulp. Of easy access to London, paper from this mill has been, and is still, to some small extent, sent up by road. There are no steep hills, and travelling is thus rendered more simple. Up to within comparatively recent times nine-tenths of the mill's output was despatched by this means. It got less handled, and therefore less injured, and if this plan is not still carried out, the knowledge of it helps to secure better terms, perhaps, from the railways.

Prior to 1864 Heap Mill, High Wycombe, was in the hands of James Freeman Gage Spicer, who manufactured half-stuff for the Glory Mills, at that time also in his possession. Previous to the above date it had been a vat mill, and in 1864 Mr. Wheeler took it for an auxiliary rag-pulping mill. Taken over by Mr. Hedley in 1895, great improvements have been made, and there are now, in addition to a machine for making news boards, two vats for making hand-made mill and leather boards.

Loudwater Mill, according to the Directory of 1860, was in the hands of Messrs. T. & W. Lunnon, but neither this nor King's Mill ever belonged to them. It was partly built in 1814–15, and contained four vats where book papers were made. A machine was first introduced in 1830–32, and writings and printings were made, as well as a small quantity of bag papers. The mill appears to have been the property of the Ecclesiastical Commissioners, and sold by them to Plaistowe, who owned the King's Mills between 1870 and 1885. To-day it belongs to Mr. C. E. Ashdown, and blotting paper alone is produced. King's Mill belonged to a Mrs. Brian in the original instance, and machines were put in at a later date, somewhat subsequent to that of Loudwater.

Perhaps of all the papers made in Bucks, there is no paper for which the county is more justly famous than for its blottings. The precise date cannot be accurately fixed, but towards the end of the eighteenth century, at a little hand-made paper-mill, situated in the village of Hagbourne, near Wallingford, Berks, the idea originated, which culminated in the production by Mr. Slade of a paper for the first time called "Blotting." This business was successfully carried on by many members of the Slade family, till it came into the hands of the late Mr. T. B. Ford, consequent on his marriage with a lady who was a direct descendant of the original inventor of blotting paper. After a time Mr. Ford transferred the business to Snakesley Mill, Loudwater, making the blotting by machine instead of by hand, but retaining all its good qualities. Here the business has gradually reached its present dimensions, the size has increased, and the latest improvements in machinery introduced.

Wraysbury Mill, in the extreme southern corner of Bucks, has been used as a flour mill, a silk mill, and, the latter part of the eighteenth century, as a copper mill. As such it was carried on until about 1840, when it was converted into a paper-mill and tenanted by Messrs. Richard, Thomas, and Percy Ibbotson, for the manufacture of machine made drawing and other paper, and was afterwards carried on by Mr. Ladelle until 1877. Subsequently an attempt was made to make paper millboards from spent hops obtained from Burton. This was not a financial success, and for a period the mill had to be shut down. In 1889 it was re-started by Warwick Isaac & Co., and waterproof paper, panel, and millboards made. No mill has a better reputation at the present time than Soho Mill, belonging to Messrs. Thomas & Green. Originally run as a vat mill by a man named Harrison, it came into the hands of Charles Venables, who worked it and failed. Idle for six years more, it was restarted by the present owners in 1868. Straw was worked up till 1894, and in addition rags, esparto, and wood-pulp. Many classes of good and medium quality paper have been produced, but colours are the principal part of their make. The site was originally chosen for water power, and a good supply of spring or artesian well water. It was doubtless taken in 1860 because it was reasonable in rent, and a lot of straw is grown in the district.

Another Home county in which paper-making has played an important part is Hertfordshire,[1] chiefly conspicuous for the fact that it contains the leading mills belonging to Messrs. John Dickinson & Co. In 1809 Apsley Mill, having already been converted from a corn mill, was purchased, and the new kind of paper made there for cannon cartridges proved of great value during the Peninsular War and the Waterloo Campaign.

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[1] See Map, p. 175.

Three machines were erected, but the number of workpeople were only about forty. In 1833 a new paper machine was substituted for two small ones, and another change was made in 1848–50, when a new machine-house was put up, and a new machine, complete with air-drying drums for making tub-sized papers. Envelope-making was introduced in 1850, and by 1888 about 20 tons of paper was being produced per week. At that date the paper machinery was removed, and the whole mill devoted to making cards, envelopes, and stationery. The weekly output is now 150 tons.

Once a corn mill, the Nash Mills were purchased by Mr. Dickinson in 1811 from A. Blackwell and E. Jones. It was here that Mr. Dickinson, about 1830, erected his machine for making fine plate and duplex paper, and in 1879 the mill was almost entirely rebuilt. Card, paste, and pulp boards have been the chief output of this mill, in addition to plate paper, and whereas in 1838 the total made was 8 tons per week, in 1873 it was 30 tons, and 1904 nearly 50.

Although devoting so much attention to the mechanical side of paper-making, Mr. Dickinson by no means neglected the commercial aspect, and finding that to meet the demands of the business it was necessary to extend his powers of production, he succeeded in buying certain lands and water rights, Home Park Mills near King's Langley, and Croxley Mills between Watford and Rickmansworth, were successively erected. Both these mills were provided with machines for the manufacture of paper, and Batchworth Mill near Rickmansworth, formerly a cotton mill, was purchased and converted into a "half-stuff" mill, where rag and other materials were prepared, so as to be ready for conversion into pulp at the other mills. A half-stuff mill was erected at Manchester, where the waste arriving from the cotton manufacturers was cleansed and prepared as a paper-making material.

Home Park Mill, built in 1825, and enlarged thirteen years later, turned out at the later date 10 tons of paper each week. About the year 1843 Mr. Dickinson chose this mill for a paper staining and enamelling factory. In 1864 a fourth paper machine was added to the mill, and in 1878 the first colouring machine was put up, prior to which time all the paper staining had been done by hand. In 1883 this machine was destroyed by fire, but was soon made good, and the colouring works further developed by the addition of a new building containing two machines. The mill underwent an entire change after 1888, in which year it was finally closed as a paper-mill, and the space thus set free was utilised in 1890 by building a large colouring mill of three floors, and substituting turbines for the old water wheels which had previously driven the machinery. At the present moment, besides the hand colourers for special work, the mill is equipped with eight colouring machines, turning out all kinds of cromo, enamelled, coloured, and art papers and cards.

Croxley Mill commenced working in 1830, and in 1838 was making about 14 tons of paper per week. It continued with little alteration until 1881, when the beater-house and machine-house were rebuilt, and a new machine substituted for one of the old and narrow ones, turbines put in place of water wheels, and a new steam engine erected. In 1886 it was decided that this mill should prepare all the materials, and make all the paper that had formerly been made at Two Waters, Frogmore,[1] Apsley, Home Park, Batchworth, and the Manchester Mill, and a very comprehensive scheme of enlargement had to be carried out.

At Croxley Mills there are now made from the six machines all the better kinds of paper, such as tub-sized and writing papers; map, lithographic, and plate papers; highly glazed papers for magazines and illustrated journals; and the best paper for printing Bibles and all classes of books.

Though all the mills were established before the age of railways, Mr. Dickinson, with his usual forethought, chose for his enterprise, a locality provided with excellent water carriage, and if there is any peculiar advantage possessed by Hertfordshire for paper-making purposes, it is this excellent means of carriage—cheaper as well as cleaner than the more modern railway.

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[1] Frogmore and Two Water Mills, situated immediately above and close to Apsley Mills, were taken in 1887, and paper was made at the latter from esparto prepared at the former.

A certain number of mills are situated in Devonshire, where labour is cheap and good pure water accessible. An important mill in this county, and one with an interesting record, is Hele. Founded in 1767, for a considerable period only vats were used; from 1834 to 1852 machines were worked in addition, and since about that date have been the only means for the production of paper. Rags have always been the main class of raw material worked, and esparto and wood used only in a small degree. The range of production has gradually increased, and in addition to the rag printings and engine-sized writings, a large quantity of tub-sized writings is made. During the vat period 2 tons per week of high-grade paper was made. With the introduction of machines a larger output was possible, but paper of an inferior quality produced, and Hele Mill proved no exception to the rule. When Mr. Collins took it over in 1852 he cleared out both vats and machines, and made it a one-machine mill, with the widest machine in England and up to date in every respect, and 15 to 20 tons per week of printings, fine news, and collar papers, were turned out per week. In 1897 this mill, although in good condition, was hardly up to modern requirements, and many new appliances have since been added for the extension and enlargement of the business.

So closely connected with the cotton trade as Lancashire [1] is, any other industry must of necessity take a relatively unimportant place. Though there is a greater quantity of paper made in this county than any other in Great Britain, its history of paper-making cannot as a rule be traced back many years. The mills are nearly all of fairly modern development, but that development has been so great during the last twenty to thirty years that Lancashire adds an interesting page to the localisation of the industry.

The conditions which have led to such an enormous development in Lancashire are plainly indicated. Cheap coal, efficient labour, great concentration, and a position which gives favourable access to a wide range of markets. The unit of weight per mile is highest in Lancashire, but measured by value of product the county average is not the highest.

Although so many of the mills are modern compared with the Southern counties, the Lancashire industry has been characterised by the same vicissitudes. Many mills have had a chequered career, and there has been a good deal of capital sunk and lost in Lancashire paper-making. But the favourable situation or equipment of those that remain has made for the industry a profitable stronghold.

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[1] See Map, p. 189.

Perhaps one of the oldest is Oaken Clough Mill, Garstang, now belonging to Mr. Harold Jackson. One of the very few which originally contained vats, machines were introduced in 1820. Every class of raw material has been used, but the chief output has always been small hands, caps, and general wrapping papers. Good water power was probably the reason for the site, and apart from the gradual development of trade, and a change from water to steam power, the alterations have not been many.

The Ramsbottom Paper Mill was started in the year 1857 by Messrs. J. B. Ingham & Sons. The reasons guiding the choice of the site and location would be close proximity to the railway station and its nearness to the principal towns of Lancs. and Yorks, The materials used were mostly old bagging, jute and manilla ropes, and casing and wrapping papers of various descriptions were made. Changes have occurred at different times. About the year 1870 the mill was taken over by the Ramsbottom Co., and they altered its character in many respects. A glazing plant was put down so as to make glazed casing papers as well as glazed cartridge and other coloured papers. Wood-pulp began to be used largely about this time, as well as esparto, straw, and new rags, for making better-class paper. About the year 1890 trouble with pollution of the river occurred, and this interfered with much of the work, and led to the giving up of esparto, straw and other material that required boiling. In addition, very expensive plant had to be put down for the pumping of the effluent. The mill stands in the centre of a busy district and a fairly large population, and as it was never thought feasible to put down a soda recovery plant, the character of the papers manufactured has been restricted, and the number of machines remains the same.

A mill with distinctly special characteristics is Elton, belonging to Messrs. J. R. Crompton Bros. Started in 1856, the materials used have, for the most part, been linen and cotton, and the papers produced coloured and white tissues and copying. The mill situated in between the river and canal, grew between 1860 and 1880 with great rapidity. Commencing with one machine, it now has seven, and the works have increased in size in other directions and in the same proportions. Another mill making a somewhat similar class of paper is the Kearsley Works, which was altered from a bleach- to a paper-mill some eighty to eighty-five years ago. Between 1860 and 1870 it was taken over by Messrs. R. Fletcher & Sons, Ltd., the present proprietors, and they at once left off making a large variety of special coloured cartridge paper, and confined their attention almost entirely to tissue, copyings and thin writings.

One of the old mills in Lancashire, the Bridge Hall Mills, belonging to Messrs. J. Wrigley & Sons, Ltd., existed in the eighteenth century, and the record shows that both hand- and machine-made paper were manufactured in 1813. Almost every kind of raw material has been used, and nearly every kind of paper made. A more modern mill, and one only adapted for special qualities of paper, is that belonging to Messrs. Bibby & Barrow, Ltd. The New Bridge Paper and Bag Works started thirty years ago, was previously used for washing the works sweepings. Jute and bagging have been worked in the making of brown papers. The site is on the river and near Manchester, and the machines have been continually kept up to date.

The Burnley Paper Mill was started in March 1876. The site and a small portion of the buildings were formerly used for calico printing, bleaching, and dyeing. All classes of wrapping have been made, and the advantageous location of the mill consists in the water rights, the close proximity to railway canal and coal-mines, and a district where suitable material and common labour are fairly abundant.

The Star Paper Mill was started in 1875. Esparto, rags, and wood-pulp have all been worked, and news, printing and long elephants made. Salmesbury Mill was built by a Company that failed as paper-makers, and was bought in 1880 by Isherwood & Brindle. Their successors, Brindle & Mather, now work rags for brown paper, the water being not of the best description, and therefore more suitable for this quality of paper. The principal alterations have been the speeding up of machinery and keeping it abreast of the times, so that the production of one machine is double what it was twenty years ago. Ordsall Hall Paper Mills were originated in 1875. News has always been produced here from various kinds of raw material, and where at the start there were only two machines, these now number seven.

Perhaps of all the towns in Lancashire there has been none, with the single exception of Bury, in which paper-making has formed a more important industry than in Darwen. The largeness and variety of its local and district productions rendered it a most important source of supply for raw material and a good water supply from the head-waters of the river Darwen attracted Messrs. Helloris to paper-making early in the century. They built the Darwen Mills, and failed about 1850. The mill was rebuilt in 1860 by James Dimmock and others. It has always made printings and news for the largest offices throughout the United Kingdom. The town is a thrifty one and in front of many others in the co-operative movement, and to employ the capital accumulated by the stores, the members decided to form a Company and to erect a brown-paper mill. A suitable site was selected in Lower Darwen. Operatives started with one paper-making machine in 1872. Another was added in the next year, and the business prospered vigorously from the very start. In 1875 the Company determined to acquire the large works and estate known as Sping Vale Print Works, in order to rebuild the place as a white-paper mill. This, after some difficulty, was accomplished, and three machines were put in for the output of news and printing.

Finally, in 1893 the Darwen Mill, formerly owned by Jas. Dimmock & Co., containing three machines, with a total production of some 100 tons per week, was purchased by the Company. The new owners spent considerable sums in reconstructing and improving the mill and its plant, with the result that the weekly output has since been doubled. At the present moment the annual production of the Company's three mills considerably exceeds 25,000 tons.

The mill at Radcliffe belonging to the East Lancashire Paper Company, has been a successful property. Like a good many others in Lancashire, this mill was established during the expansion caused by the repeal of the Paper Duties. Two machines were put in at the commencement, and three others have since been added. In the earlier years before the introduction of wood products, the materials consisted principally of esparto grass, rags, cotton, linen waste, but after 1885 chemically prepared wood-pulp displaced the waste and a portion of the rags previously used. News, long elephants, and printing papers were at one time the leading papers made, but the better qualities have now been added, such as art, litho, and chromo papers, During the last seven to eight years the whole of these mills have been rebuilt, or brought up to date by alterations, and as the water has not been very clean, much money has been spent on a new receiver and watercourses for fresh water.

The two paper-mills of the Sun Paper Company are fine properties and well equipped—one at Pendleton and one at Feniscowles. Both were built originally by owners who failed: the Pendleton Mill by Chadwick & Sons and that at Feniscowles by the original Feniscowles Paper Company. A. M. Peebles & Sons have developed two fine mills from premises which were originally built by limited companies that failed, viz., the Rishton Paper Mill Company and the Whiteash Paper Company.

Yates, Duxbury & Sons own two mills; and the one at Heap Bridge was formerly owned by the Heap Bridge Paper Company, which went into liquidation. The mill is now making printings with success.

At Hall-in-the-Wood the Duxburys have been established half a century. Tough bond papers and other similar specialities are made at this mill.

Hollins Mill at Darwen was erected on another tributary of the river from which the town takes its name. Messrs. Potter & Company built this mill to make their own paper for the paper-staining industry—which has always been an important trade in Darwen under the Potter firm. The mill uses esparto and makes good printings and is now owned by the Wall Papers Combination. The Company also own another Mill at Darwen formerly worked by Almond & Co., the successors of Wood & Almond, who built the mill about 1865.

There are paper-mills at Roach Bridge, Newton-le-Willows, and Horwich—all of them successful makers in their own line of production, and favourably known by buyers all over Great Britain, and last, but not least, there is the famous Barrow Mills of the Kelner-Partington Company, situated in the extreme west of the Furness district. The site was chosen for easy access by sea. The promoters of this enterprise intended it for a pulp mill to supply Lancashire with sulphite pulp. But very early in its career this idea was abandoned, and the Company converted the buildings into a paper-mill, fitting it with the very best plant for producing printing papers from wood. They still continue to import wood and make sulphite pulp for their own use.

Welsh [1] mills are not numerous, but the country contains several large and important ones. Probably the oldest is the Millbrook Board Mill. Originally a vat mill, a small machine was introduced for making browns and manilla for packing purposes. During the last thirty-five years it has, however, been worked for hand-made millboards.

Another mill in this district is the Ash Paper Works, which was started as a machine mill in 1835. For many years it was famous throughout the West of England and South Wales for its shop or grocery papers, owing to the brightness of the colours produced. About 1870 the manufacture of these papers had to be given up—a result of the extreme cheapness and low quality of the paper rapidly coming into use for grocery purposes. The mill was then put on to making rope browns, largely worked for bag papers, and lofts were added which enabled it to compete in air-dried papers. The location of the mill was decided by the water power, there being a clear fall of 26 feet from the mill pond, and supplied by the Grwyncy Brook, to the level into which it discharges.

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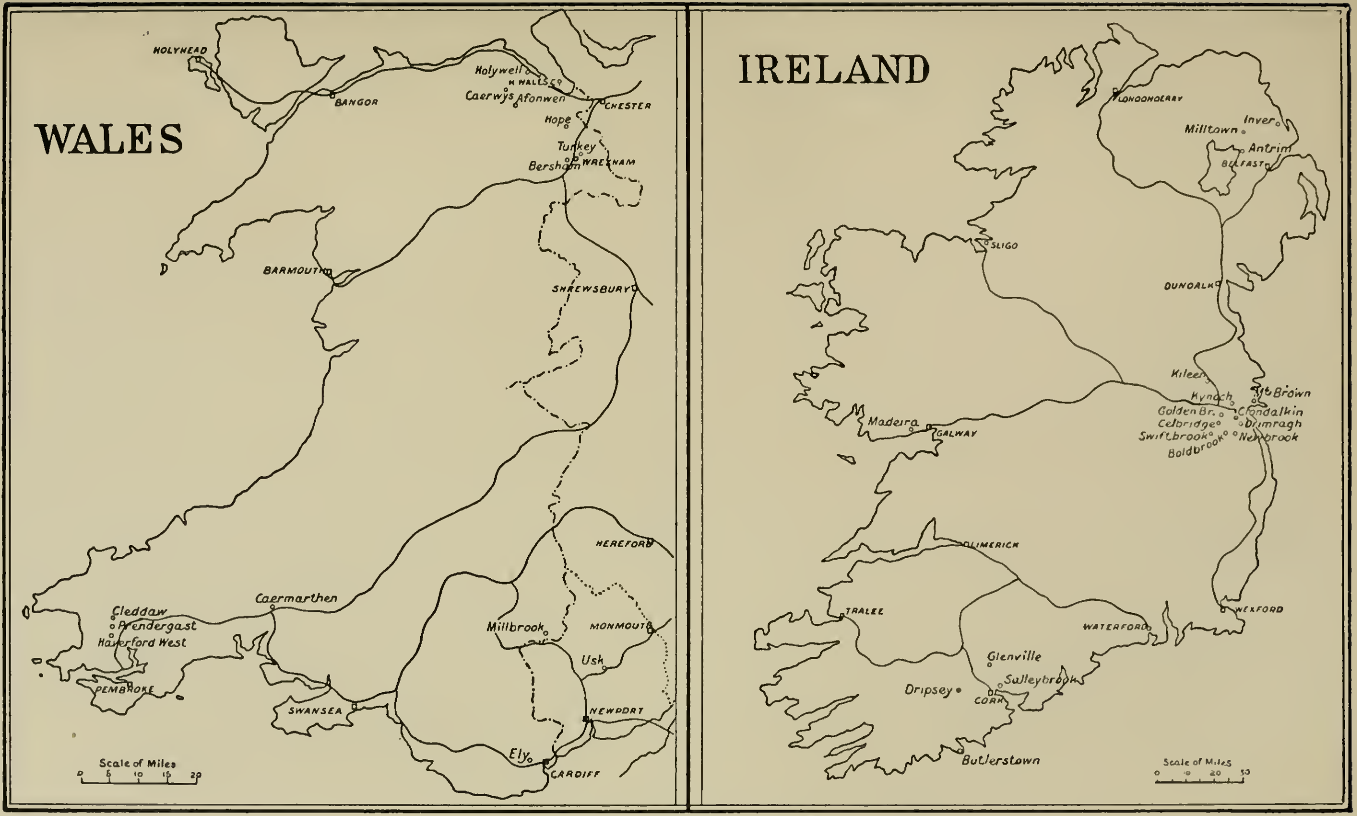
[1] See Map, p. 209.

The old water-wheels were replaced by turbines in the year 1887-8, and within the last fifteen years the whole of the machinery in the mill has been practically renewed and brought quite up to date. Steam power was added in 1900, and the rate of wages increased proportionately with the improved class of papers produced.

Perhaps the two largest mills in Wales are the North Wales Paper Company and the Ely Paper Works. The former in the north-west corner was started in 1871 with one machine. The choice of location was originally decided by the water supply, the railway facilities, and the proximity of cheap fuel. The materials used were for some time entirely straw and esparto, but, when wood-pulp came on to the market, the former was discontinued. News, white and coloured printings have, in the past, been largely produced, but the mill is now engaged in the production of a better class of printings, and of engine-sized writings. Many changes and additions have occurred from time to time. In 1880 the mill was practically doubled in size, as a second machine



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was put down. Three years ago very extensive alterations were made, including new engines and beaters, a new salle, the instalment of electric power, and the lengthening and improvement of the paper-making machines.

The Ely Paper Works—the mill belonging to Messrs. Thomas Owen & Co., Ltd.—situated outside Cardiff, was founded about forty years ago. At first a two-machine mill, it was at a later date increased to four, and within the past eighteen years has doubled its number again. Using esparto, straw, rags, and wood-pulp, the owners have chiefly been engaged in the production of news, and placed as it is near coal and the sea, the location of the mill is an excellent one.

Holywell Mill has been owned since 1856 by Messrs. Grosvenor, Chater & Co. It was probably started about 1840, and before that date there had been some other works on the site. The water power of St. Winifred's Well Stream is the main feature of its location, and the mill has been gradually increased from a capacity of making 4 tons a week of rag and esparto writing and printing papers to 60 tons at the present time.

Paper-making in Ireland[1] dates back for over a century, and fifty or sixty years ago scores of mills throughout Ireland were in successful operation. Compared with present plants these mills were generally small, while their equipment was primitive in the extreme, and with the advent of improved methods and machinery introduced by English, Scotch, Continental, and American manufacturers, many of these mills found it impossible to compete, and one by one were suspended.

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[1] See Map, p. 209.

Of the mills which are still existing perhaps the Swift Brook Mills, Saggart, has the most interesting record. Old leases show that the mills were installed in 1795. For many years a vat mill, a machine was erected in the upper mill in 1848, and another in the lower mill at a slightly later date. Rags, esparto, and flax have all been worked, and within the last ten years small quantities of wood-pulp to meet the demand for lower qualities of paper. At the present time the raw material is almost entirely confined to linen and cotton cuttings and old rags. Up to 1879 printings and tub-sized writings were the only papers made, but since 1881 the variety has largely increased. It was in that year the mills were sold by order of the Chancellor, as the former proprietor, Mr. W. W. McDonnel, had died some years previously, and the estate had to be wound up. In 1890 an extensive reconstruction of the mill took place, and in 1905, as additional beaters were required and there was no water power available, steam and electric plant were put down to provide the necessary force.

An exceedingly important factor among Irish mills is the North of Ireland Paper Company. Their Ballyclare Mill was started about 1834. For some time a vat mill, the date of the introduction of machines is uncertain. A plentiful supply of water and reasonably cheap labour were the reasons guiding the choice of location, for there were no special facilities in carriage either of the raw material or manufactured article, and the coal needed had to be imported from England or Scotland. All kinds of raw material have on different occasions been worked and papers of various classes produced, but principally printings, engine-sized writings, news, cartridge, and parchments, and since 1870 there have been four machines added, and the total output has increased from some 5 to 180 tons per week.

Their Larne Mill was built in 1885, and the site was chiefly chosen by reason of its water supply and convenience to a shipping port. It has always been a one-machine mill, manufacturing caps, writings, and mill glazed papers, from all kinds of rags and the various grades of wood-pulp.

No county in Scotland[1] is more important from the paper-mill standpoint than Midlothian. The purchase of ground for the Springfield Paper Mill, now belonging to Messrs. Tod & Co., was made in 1743, and the actual commencement of the mill as a working centre took place a year later. There were two Fourdrinier machines in it by 1850, but about 1863 the mill was shut down. Bought in 1866 by the late Mr. W. Tod, and extensive alterations having been made, the mill was restarted at the end of 1867.

The older of the two paper-making machines was taken out in 1899 and a modern one substituted.

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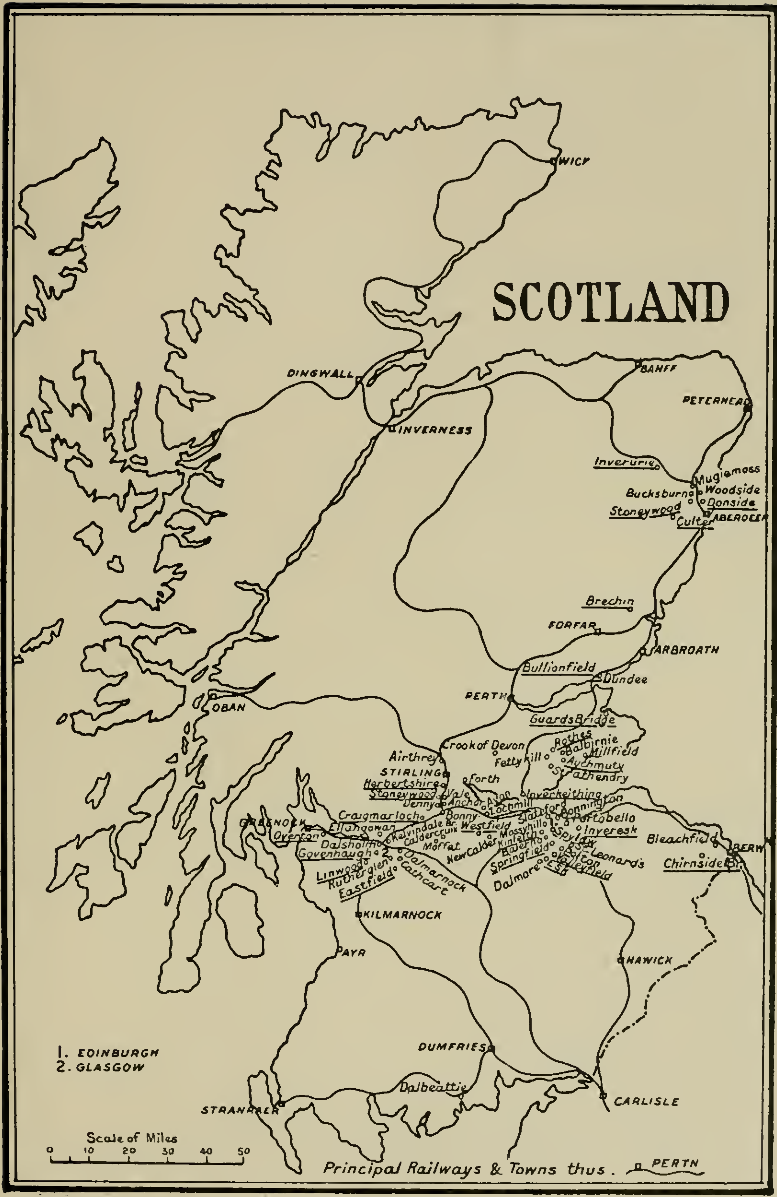
[1] See Map, p. 213.


SCOTLAND
WICK
DINGWALL
INVERNESS
BANFF
PETERHEAD
Inverurie
Mugiemoss
Bucksburn
Woodside
Donside
Stoneywood
Culter
ABERDEE
Brechin
FORFAR
ARBROATH
Bullionfield
Dundee
PERTH
OBAN
Guards Bridge
Crook of Devon
Rothes
Balbirnie
Millfield
Fettykill
Auchmuty
Strathendry
Airthrey
STIRLING
Forth
Herbertshire
Stoneywood
Vale
Avon
Inverkeithing
Denny
Anchor
Lochmill
Bonnington
Craigmarloch
Bonny.
Slateford
Portobello
GREENOCK
Ellangowan
Kelvindale Br.
Westfield
Mossyhill
Inveresk
Overton
Caldercruix
Kinleith
Spylaw
Bleachfield
BERW
Dalsholm
Moffat
New Calder
Balerno
St. Leonard's
Govenhaugh
Springfield
Polton
Chirnside Br.
Linwood
Dalmarnock
Valleyfield
Rutherglen
Cathcart
Dalmore
Esk
Eastfield
KILMARNOCK
AYR
HAWICK
DUMFRIES
Dalbeattie
CARLISLE
STRANRAER
1. EDINBURGH
2. GLASGOW
Scale of Miles
0 10 20 30 40 50
Principal Railways & Towns thus. PERTH

Prior to the stoppage in 1863 the mill made almost entirely tub-sized writing papers from rags, but since 1867 its production has consisted of engine-sized esparto papers containing, in some cases, a proportion of rag, and of late years a certain amount of chemical wood-pulp. The actual site of the mill on the banks of the Esk was doubtless chosen for its water power, proximity to Edinburgh (always a great printing centre) and the Port of Leith. It is said, though the statement cannot be actually proved, that in the old days, when the mill made writing papers, they generally got a ¼d. per lb. more than Joynsons did for their papers.

The mill belonging to John Tod & Son at Lasswade possesses no records to show when it was started. Belonging to the present family for sixty years, the mill at one time possessed vats, as it contained a drying loft with hair ropes. The ordinary raw materials have been used, and in addition Palmetto leaves were tried. All kinds of engine-sized papers are made, and the mills have been kept up to date without any radical changes in construction having occurred.

The mill belonging to James Brown & Co. on the Esk was started in 1790. Vats were first of all employed, and paper-making machines put in about the year 1820. The ordinary raw materials have been worked, and superfine, fine printings, super-calendared, chromo, enamelled, and art papers produced. Within the last twenty years the whole mill has been practically remodelled. There are now four instead of three machines. Additions and enlargements are continually being carried out and motors gradually replacing all steam engines.

Valleyfield Mills, belonging to Messrs. A. Cowan & Sons, Ltd., were started in 1709, and for 112 years only hand-made paper was produced. Machines were introduced in 1821, although for twenty-five years after this vats were used for part of the manufacture. The better kinds of rags, esparto, and wood-pulp have been used in making the best class of tub-sized writings and the more superior qualities of engine-sized writings and printings. The site, originally occupied by corn mills was considered suitable because of the presence of water in sufficient quantity both for power and manufacturing purposes. Additions and alterations have been almost continuously going on, and every valuable improvement adopted as it is discovered. Within the last fifteen years the mills have been, for the most part, reconstructed, both as regards building and machinery, and also greatly extended.

Spylaw Mill, started in 1871, has always been well off for water and the raw material necessary for making millboards. The only extensions have been in the drying power—a most important factor in this class of manufacture.

The famous Polton Paper Works, belonging to Messrs. Annandale & Sons, Ltd., was started about two hundred years ago, and for a fair time of its existence was entirely a vat mill. Machines were introduced in 1835, and rags only have been used in the production of the highest qualities of ledger and writing papers.

Kinleith Paper Mill, situated on a stream, started as a hand-made mill with six vats about the middle of the eighteenth century. Up till 1862 rags were the only material worked, since then esparto to a larger, and rags and chemical wood-pulp to a smaller extent have been used. Fine printings have always been produced, but of late years engine-sized writings, imitation arts and plate papers have been added to the list of qualities manufactured. The first machine was introduced in 1831, the second in 1860, the third in 1864 (replaced in 1903), and another in 1877. When Mr. Bruce came to the mill in 1844 the make of paper was 4 tons per week; the output averages now 110 tons.

A good supply of pure water and close proximity to coal-fields and Leith Docks were the main factors in selecting the situation for Portobello Mills some sixty years ago. Rags were soon replaced by esparto as the leading raw material, and where strong-coloured rag papers and blottings used to be made, fine engine-sized writings, cream laids, and printings are now the chief qualities of paper manufactured. The productive power of the mill has been steadily increased, and the alterations and extensions in the shape of new plant were commenced July, 1903.

Bonnington, near Leith, is by no means a typical Scotch mill, on account of the class of paper it makes. Founded in 1870, rags, bagging, ropes, and waste paper have been worked in the making of browns, greys, duplex, and felt papers. On the other hand, the Inveresk Mills, near Musselborough, have always been engaged in using esparto, straw, and wood for the production of fine printings and art papers. Both are close to the sea, and the latter is especially helped by the absence of pollution trouble.

South-east of Edinburgh, on the river Whitadder in Berwickshire, Chirnside Bridge Paper Mill was started in 1842 with one machine. A second was introduced nine years later, and a third in 1897. Rags were used until the introduction of esparto, and this mill was one of the first to change to the new material. The best class of rag and esparto papers have been made, and since 1897 tub-sized writings. Several remodellings of machines and plant have taken place, and the mill is modern in all respects.

Loch Mill, Linlithgow, was founded early last century. At one time a vat mill, the date of the introduction of machines is uncertain. Rags and esparto for the production of news, writings, engine sized writings, have always been worked, and the plant has been increased and the premises extended to suit the times.

Craigmarloch Mills, at Killigth, were started early in the last century, but there is no information regarding it until Messrs. Martin & Co., the present owners, took it over in 1870. Millboards were made in vats until 1890, and by machine continuously. The materials used have been ropes and waste paper, and of late the mill has been reconstructed and renewed and its capacity for production more than doubled.

Eastfield Mills at Ratherglen, belonging to Messrs. Stewart Bros., became a part of the paper-making world in 1890, and have always used railway tarpaulins, linen, cotton, and jute rags for their output of browns and grocery papers. There have never been any pollution troubles, always an abundance of coal and raw material, and a ready market for the sale of the paper.

In the same county there are two other important mills. The Westfield Paper Co. was started about 1834, and machines were at once introduced. The original class of paper made was brown, and rags and ropes were used in the production, but for the last thirty years better qualities of white papers have been made from the finer grades of esparto. The reasons which guided the choice of location were—a very ample supply of water, and the immediate proximity of large coal-fields and railway facilities which included private sidings into the works. The changes have been numerous and the mill has, of late years, been almost entirely rebuilt and equipped with the most modern machinery. There are now two machines, and the output possible is some 80 to 90 tons per week. Avon

Mills, belonging to Messrs. J. Lovell & Sons, commenced working in 1860, and esparto has always been the raw material used in the production of cream laids, engine-sized and fine printings. Additions and alterations have been made, which were necessary to enable successful competition with other mills.

The mill belonging to Messrs. R. W. Watson, at Linwood, in Renfrewshire, was started thirty-two years ago with one 86-inch American machine. A Fourdrinier, 84 inches in width, was added in 1887, and at the present time a similar make, but of greater width, is being put down. All qualities of wrappings are made from old hemp, manilla ropes, and jute flax. There are suitable water facilities, and the proximity to the principal Scottish market was an important factor in the choice of location.

The mill now belonging to Mr. E. Collins, Maryhill, near Glasgow, was started in 1746 at Dalmin, Dumbartonshire, and removed in 1857 to Kelindale. Originally it had eight vats, but the first machine was introduced in 1822, the second in 1828, and the third in 1883. Rags, esparto, and wood-pulp are the different classes of material treated, and the papers produced—writings, printings, blottings, and pulp-boards. A Fourdrinier machine was put into the new Overton Paper Mill in 1827. The situation was selected for the good water and advantageous freights. Rags were at first used, and long elephants made. Now esparto is worked, and while in the early stage of this raw material newspapers were produced, there are now writing and printing papers made.

Milton's Mill Bowling, founded about fifty-five years ago, possesses good water, cheap coal, and is conveniently situated for cheap freights either by rail or steamer to the leading towns in England and Scotland. Rag, esparto, and wood-pulp are the raw materials for the production of engine-sized and tub-sized writing paper. The Herbertshire and Stoneywood Paper Mills belonging to John Collins, Ltd., were started respectively in 1845 and 1878. Both possess good water power, but while the former has made the ordinary Scotch paper, the latter has produced label manilla, strong envelope cartridge and biscuit cap, from jute, manilla, linen, and wood-pulp.

Fifeshire possesses one of the best esparto paper-mills which exist throughout Scotland in the Guard Bridge Company. Started in 1874, it has now four machines, and its paper has a world-wide reputation. The Auchmuty and Rothes Mills, now belonging to R. Tullis & Co., were taken on a 99 years' lease in the year 1804, and were then mills for making oatmeal. Converted into paper mills five years later, Auchmuty turned out only hand-made paper for many years, while Rothes is said to have contained the first paper machine Scotland possessed. To-day both are flourishing mills, and make many qualities of good printing and medium quality writing papers.

Two mills near Glasgow are Govenbaugh and

Milthoens. The former was started in 1874, and brown paper has been always made from rags, bagging, and waste material. The latter was started in 1693, and for over 150 years only made paper by hand. Rags have been the raw material most largely used, and the usual ranges of paper at a tub-sized mill have been made. It has been kept fairly well up to date and all the important changes made during the last century.

An extremely modern mill is that belonging to Messrs. Caldwell & Co., Inverkeithing, founded in 1895, and making printings, writings, and grease-proof parchments from esparto, rags, and wood-pulp. The situation is on the coast, and the mill possesses good water and cheap coal and freights.

In Forfarshire there are two mills of especial interest, belonging respectively to Messrs. Guthrie, Craig, Peters & Co., and Messrs. D. M. Watson & Co. The former was founded in 1851, and has tried, in addition to the ordinary raw materials, the use of Palmetto leaves. For the first twenty years common printings, news, cartridges, and grocery papers were made, at a later date glazed casings and browns, and in 1881 a second machine was introduced for caps and manillas. During the last eight years bag-making has been added to the other manufactures. Bullionfield Mill was converted from a bleach mill into a paper-mill in the early part of last century. It was never a vat mill, as machines where put in at the very start. Raw materials used at different times have been ropes, rags, straw, and esparto, and papers of all kinds made. There is a good water supply, and a port is near for the arrival and despatch of goods. The mill has been completely rebuilt, remodelled, and kept up to date in every way, and its reputation for esparto printing papers is unequalled.

Aberdeenshire possesses several mills of repute, and of these the Donside Paper Company, is the most modern. Started in 1885 by the Gordon Paper Company, brown paper was made for eight years, and then for two years there was a brief attempt at making printing and writing papers. In 1892 that Company failed, and the mills were sold in 1893 to their present owner. The papers now made are printings and news, and the only material used is wood-pulp. There is an ample water supply, and a seaport is within close proximity. The whole mill has been practically rebuilt in the last ten years, and is now entirely driven by electric motor.

Inverurie Mill, belonging to Messrs. Tait & Son, was started in 1860. The reasons which caused the choice for location were that it was near the railway, and able to obtain a good supply of water from the river for motive power. At first the only material used was rags, but esparto and wood-pulp have both been worked in the making of all ordinary classes of commercial papers. A sulphite mill was put down in 1885, and formed the most important change in its history.

The mill belonging to Messrs. C. Davidson & Sons, Ltd., was started in 1796, and was originally a vat mill. A machine was first of all introduced in 1830, and its manufactures have been browns, grocery, ammunition, and bag papers. Waterton Mill was originally used for wool manufacture, and not taken over till 1860, and for some twenty years or so thin browns, coloured papers and boards were made.

No mills in Scotland have had a more interesting history than the Culter Paper Works, and the various developments which have taken place within its walls represent in no unimportant manner some of the changes in the Scotch paper industry. An advertisement appeared in the *Aberdeen Journal*, January 8, 1751, that Bartholomew Smith, paper-maker, from England, who had rented and set going on the Burn of Culter, a paper-mill, was able to "serve the country in paper, fine and coarse, brown paper, pasteboard, pressing card for dysters, &c." His staff consisted of six men, to-day there are five hundred, who, with the best of modern appliances, are able to place on the market every week more than 100 tons of paper. Every Friday he went to Aberdeen to buy "rag of all kinds, of flax or hemp by the stone weight," and his venture at Culter is notable as the earliest example, in the neighbourhood of Aberdeen, of a paper-mill, which has been carried on continuously till the present day. An earlier attempt was made in 1696 at Gordons Mill, by Patrick Sandilands, of Cotton, but after several years it was discontinued.

Mr. Bartholomew Smith was succeeded in business by his sons, and the younger one worked at it till his death in 1819. During his management the most notable incident appears to have been the purchase, in 1808, of the plant of the Devanha Paper Mill, of Messrs. Brown & Chalmers, built at Craighy, in Ferryhill, 1803. The next manager was Mr. James Smith, who at once entered into partnership as a paper-maker with Mr. William Tullis, at Leekie, in Fifeshire, and proceeded to dispose of the business at Culter. The connection of the Smiths with the Culter Mill ceased on November 15, 1820, when it was purchased for £4,000 by Alexander Irvine, of Aberdeen, who carried it on till 1838. The works then passed into the hands of Messrs. Arbuthnot and McCrombie. They did a good deal for the business by improving the plant and enlarging the premises, and in 1840 there were sixty hands in their employment. In 1856 the mill was acquired by Messrs. A. Pirie & Sons, of Stoneywood, and they, nine years later, floated a joint stock company, by whom, under the title of the Culter Mills Paper Co., Ltd., the business is still carried on. Many notable extensions and improvements have taken place in the works, and new lines of production have been instituted—from hand-made to machine-made papers—from cheap or low-class papers to fine ones, and about one-quarter of the whole output of the present Company consists of the art-enamelled papers, a leading speciality of this mill.

The latest extensions, now complete, have brought the resources of production thoroughly abreast of modern times.

APPENDIX B

THE PAPER TRADE IN OTHER COUNTRIES

THE paper industry in foreign countries is different in two important respects from that of Great Britain. In the former, imports and exports, both in the raw and manufactured condition, have been more subject to prohibitive tariffs than in this country, and in the second place the use of esparto has been practically confined to England and Scotland. In describing briefly the distinctive characteristics of the European, American, and Asiatic paper trades, these differences must be constantly borne in mind. The policy of protection has compelled many of these countries to be largely dependent on their own resources, and consequently rags and wood-pulp have been the only available raw material.

As the home of Nicholas Louis Robert, the originator of the first paper machine, France may, perhaps, rank as the pioneer in the early history of the modern paper trade. At the commencement of the century she is said to have had five hundred mills, but these, of course, only produced hand-made paper, the first machine in France not being made until 1811. It was built by M. Calla, engineer for the MM. Berth Grevenich, and for some years his machine was the only one at work. The first machine made by Messrs. Bryan Donkin & Co., for France, in 1822, was sent to Mr. Carson the following year, and two others followed in 1824 and 1825. A little later the Jury of the Exposition proved the existence in France of 4 machine mills in 1828, 12 in 1834, and 200 in 1847.

The number of people employed in paper manufacture in 1850 was said to be 14,500—almost twice as many as were working at that time in England. But the total output was only about 41,000 tons, including 2,000 tons made from 250 vats, as compared with 80,000 tons in England from 250 machines and 120 vats.

The imports of rags into France increased from 723 tons in 1849 to 7,200 in 1860, but then fell to 4,600 in 1867. In the same year 266 tons of paper were imported. It happened that exports of paper varied in about the same proportion as the imports of rags, while, as a result of the revised tariff of 1861, the export of rags, instead of being prohibited, was subject to a duty of £4 11s. per ton, and in 1864 £1 11s.; altogether it amounted, in 1868, to 1,300 tons.[1]

One of the disadvantages which France has always had to face is that, among Continental countries, she has the smallest amount of forest land available for supplying herself with wood-pulp. It is therefore possible that in the future she may consider the advisability of using esparto grass as a raw material. The cost of chemicals and coal, has, in past years, barred the way, but these difficulties could, to-day, be overcome.

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[1] The majority of these statistics are to be found in Mr. Munsell's "Paper and Paper-Making Chronology."

In addition, waterfalls are not lacking in France —a fact that those who know Vosges and Isère will appreciate. The transport of esparto has also been cheaper to Scotland than to France, because it serves as return freight for English ships which frequent the ports of Algiers, Tunis, and Egypt. But if these points were examined with more care and closer investigation, perhaps paper might either be made in Algiers for French consumption or possibly even in France itself. The French paper trade does not appear from the export figures to be progressing with the same rapidity as is the case with certain other countries on the Continent; and although it is doubtless true that she deals in more special classes of paper, no industry can become of national importance unless based on a large output of the cheaper qualities.

The history of the paper trade in Germany can only be briefly noticed. The quantity of rags[1] and of straw pulp[2] used has been increasing gradually throughout the century; and the difficulty which the paper-makers frequently met with in procuring a sufficient supply of the former caused

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[1] See Diagram XXVI.

[2] Ibid.

DIAGRAM XXVI.—AMOUNT OF CHEMICAL, MECHANICAL, AND STRAW PULP AND RAYS USED IN GERMANY

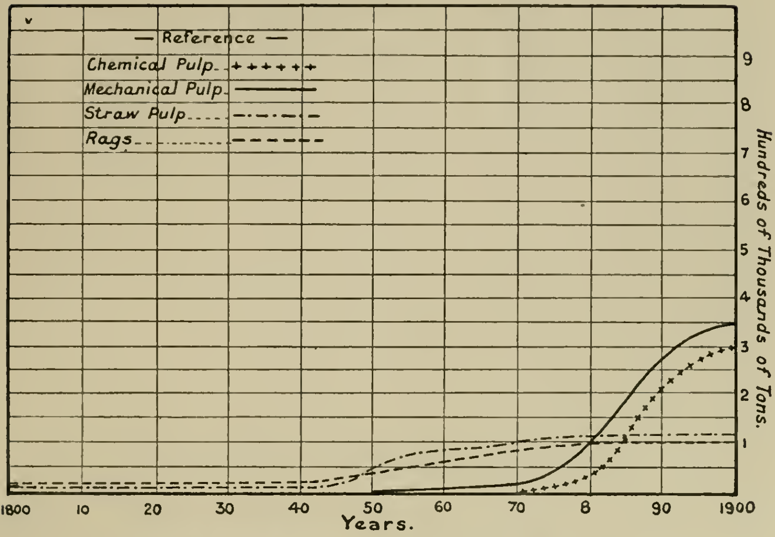

Diagram from Kirchner's History of the Paper Trade

DIAGRAM XXVII.—NO. OF VATS AND MACHINES IN GERMANY

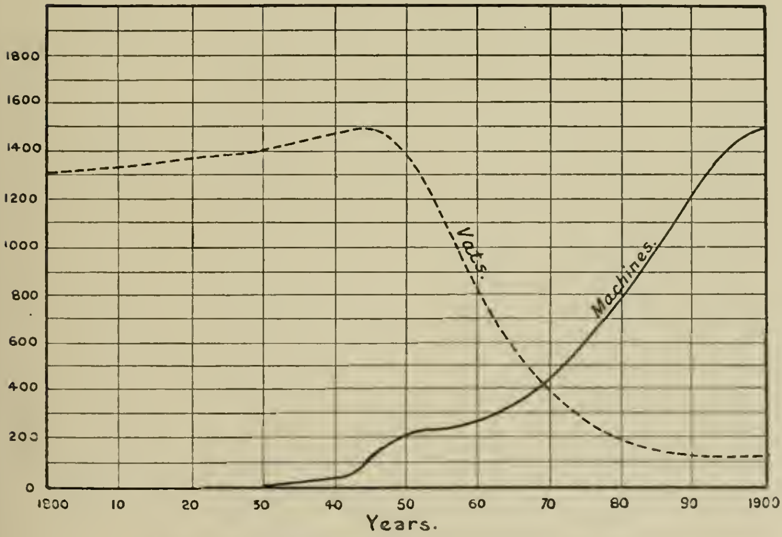

Diagram from Kirchner's History of the Paper Trade so much jealousy and strife among them that many German States established so-called rag districts, each of which were allotted to different paper-mills as their sources of supply. In 1800 there were said to be 500 mills, containing 1,300 vats,[1] and making some 1,100 tons of paper. About thirty years later machines[2] were introduced, and in 1840 the total output was 40,000 tons.[3]

The process of utilising soft wood for making paper, invented by a Saxon weaver in 1845, caused a considerable increase in the paper production throughout Germany, which, in 1860, was about equal to the output of England, viz., 100,000 tons. In 1871 was set up the first paper-mill, worked upon the new method involving the use of caustic soda, and in course of a short time many other such mills were established.

Both mechanical[4] and chemical[5] wood-pulp have been used in constantly increasing quantities since that date, and to-day Germany, with an output of over a million tons, ranks next to the U.S.A. as the most prolific paper-producing country in the world.[6]

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[1] See Diagram XXVII. [2] Ibid. [3] See Diagram XXVIII.

[4] See Diagram XXVI. [5] Ibid.

[6] From recent statistics of the world's paper production by M. Kravany, the total amounted in the year 1900 to 5,149,000 tons. The leading producing country was the United States of America, with about 2 million tons, followed by Germany, England, France, Austria, Italy, Russia, Finland, Canada, Sweden, Norway, Spain, Belgium, and Holland, in the order of importance as given; all other paper-producing countries together accounted for about 6 per cent. of the total (*Paper Makers' Monthlv Journal*, 1907).

Her exports of paper have increased from 45,000 tons in 1882 to 133,000 tons in 1904, and her imports at the present time are about 24,000 tons. The import duty on paper has largely decreased, and in 1874 the export duty on rags was removed altogether.

DIAGRAM XXVIII.—TOTAL PRODUCTION OF PAPER AND BOARDS IN GERMANY

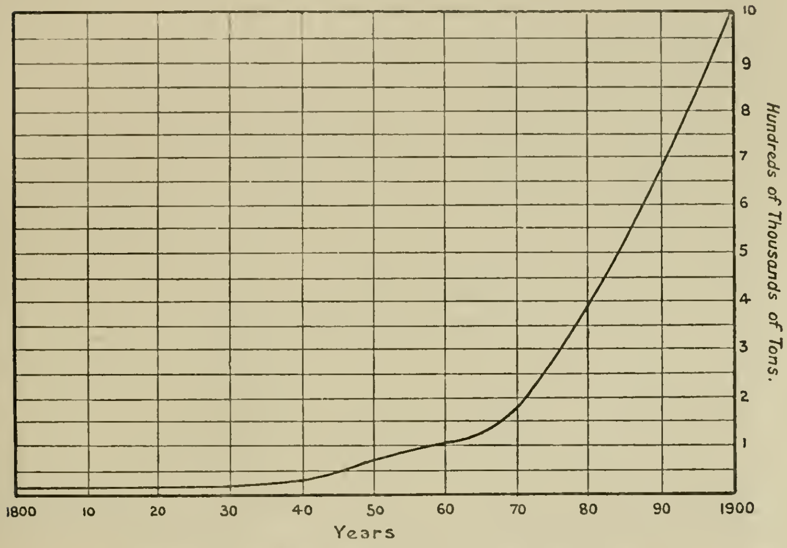

Diagram from Kirchner's History of the Paper Trade

The manufacture of paper and pasteboard is carried on in all parts of the German Empire, but the most important centres are situated in districts where the chief raw material, viz., wood, is near at hand, or where water power can be easily utilised; thus the largest number of paper-mills are to be found in Thuringia, the Hartz Mountains, Silesia, and other mountainous regions. No just comparison can be made between the number of people employed in the German industry and the number employed in England, for, in addition to the mills solely engaged in making paper, there are separate establishments for sorting rags, and mills for manufacturing straw, mechanical and chemical pulp. In 1904 the number of people employed in all these factories was 73,000 and the wages earned totalled nearly £3,000,000.

Two other features in the modern paper made in Germany should be remarked. The most important branch of the industry is, as in other countries, the manufacture of newspaper on reels.

(1) In the year 1900 a cartell to last five years was formed by twenty-nine of the most important German mills producing exclusively printing paper for newspapers, with a view to controlling this branch of the paper industry. The principles upon which this cartell was formed were—firstly, to regulate the amount of annual output; and secondly, to fix the prices proportionate to the costs of production. A further object was to provide for the export of surplus output to foreign markets whenever there was a falling off in the home demand. Last year the cartell was renewed for another five years, and eight more mills were added to the previous number.

(2) A second important feature is the well-known official paper-testing institute at Gross Lichterfeldt, near Berlin. This was started in the year 1886

with the object, at first, merely of testing all paper furnished to the Prussian Government Offices ; but after a very short time of its existence it was used also by dealers and others who wished to have their paper tested according to the rules laid down by the institute. The object of this testing at Gross Lichterfeldt is to ascertain the composition, sizing, colour, and amount of moisture in the paper, and whether it contains many impurities, and also to determine the size, thickness, weight, consistency, toughness, resistance against moisture, power of absorption of moisture, and permeability in regard to light. The German paper manufacturers, at first, raised a stormy opposition to the establishment of this paper-testing institute, but in course of time this opposition disappeared, and it is now universally acknowledged that it has had most beneficial effects upon the industry as a whole.

In the other countries of Europe paper has played a more or less important part in the economic and industrial life of the country, but the statistics with regard to them are scattered, and it would be unprofitable to draw rough conclusions without some study of local conditions.

There is one other country in the Eastern Hemisphere which should be mentioned in this survey—Japan. Japanese paper is made principally from the bark of three trees—the koza, mtisimala, and the yamp. The first gives a much stronger paper than the second, and the third is chiefly used for manufacturing copying paper. The striking point in the manufacture of Japanese paper is the absence of machinery. Everything is done by manual labour. Factories are almost unknown, the industry being carried on in a small way by separate families, which do not employ hired labour except where their own members are insufficient. As a result of the almost entire absence of factories for paper-making, the industry is often carried on as a temporary occupation in the winter. Such conditions are not conducive to progress, and until recently Japanese paper-making stood just where it was five hundred years ago. Lately, however, much has been done to improve matters by the establishment of guilds. These look after the interests of their members and ensure them a market for their goods. At the same time the guilds have teachers in their own employ who point out to the paper-makers their mistakes.

In addition, of late, one or two paper-mills have been set up in the suburbs of Tokio, but these are almost entirely engaged in making foreign paper. Besides the paper for ordinary uses, it is manufactured in a special form for bandages, umbrellas, mattings, and handkerchiefs. All kinds are, for the most part, unsized and of a very porous character. The cement which is used binds the fibres together, but does not fill up the interstices like sizing in foreign papers. Thus it is adapted for the Japanese use of the brush and ink, the latter being absorbed. The strength also does not arise from any felting or intertwining of the fibres, but from their length and toughness. In papers of medium thickness the fibres lie in one direction only, while in thick papers the fibres cross one another at right angles.

Owing to its special character Japanese paper is little exported, and only to China is the amount and value of any importance.

In the United States of America the number of mills was 185 in 1810, 600 in 1844, and in 1854 they amounted to 750. The quantities of paper made in 1810, 1820, and 1830 were 2,000, 7,000, and 18,500 respectively. In 1847 it had risen to 57,000 tons, while rather less than the labour of one man was required for the manufacture of each ton of paper.

The importation of rags varied much from time to time—5,000, 4,000, and 19,000 tons in 1837, 1847, and 1857 respectively.[1] None were exported. The import and export of paper both, on the whole, tended to increase, although the former grew with greater rapidity than the latter.

In general, up to the introduction of wood-pulp for the manufacture of paper, the various foreign countries did not, like England, rapidly increase their output as they did afterwards. When the area of land they covered is compared with that of the United Kingdom, the proportion is almost absurd, and it is safe to say that, for the first three-quarters of the nineteenth century, England contributed 25 per cent. of the total output.

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[1] Statistics from Munsell.

In the Vienna Exhibition of 1875 different qualities of paper from all parts of Europe were exhibited.

From a general point of view the English papers were characterised by firmness and solidity, but had not, as a rule, such a close appearance as European papers.

The Austrians and Germans apparently study more the tastes of their customers, their machine writings particularly having a style of finish calculated to suit the popular taste. A close examination of English makes will frequently show that they have an intrinsic merit, which at first is not apparent, whilst with German and Austrian papers the reverse is the case. On the whole, the decision of the Vienna Exhibition was that the English paper was best.

Thus in 1873 the consensus of opinion favoured the superiority of England in the paper market of the world; but already, previous to that date, other countries were making progress, and only the introduction of esparto, and the practical monopoly of that plant by Great Britain for paper-making purposes, kept her at the top between 1860 and 1870.

About this period makers at home were complaining of ruinous prices and dulness of trade, and simultaneously large quantities of paper were imported from the Continent. In Austria, *e.g.*, they had the advantage of cheap rags, cheap labour, and large water power, and for similar qualities it was only owing to their superior machinery that the English makers held their ground. A visit made to a mill in Austria confirmed this view. It was a large mill, having force of water equal to no less than 160 horse-power. Rags were cheap and used exclusively. Everything about the mill was clean and orderly, and there was evidence of general good direction, except in respect to details of the machinery, which may be instanced by their antiquated mode of cutting the paper. Thirty per cent. more hands were employed than in a corresponding English mill. We may sum up by saying that in Austrian mills we find cheap labour, cheap power, cheap coals, and cheap fibre, all partially neutralised by inadequate machinery, and, to judge by appearances, not very efficient labour.

The same remarks might also be made of the Germans and Belgians. Indeed, it can be easily seen that, with a new source of supply close at hand, and with improved mechanical and educational methods, Continental countries were bound to threaten the supremacy of this country.

What was generally anticipated has become an actual fact, and Germany, Norway, Sweden, and Austria are the largest contributors to the European market in the shape of paper-pulp. America also, with her large supply of wood and wonderful mechanical devices, has become an immense factor in the trade. But as her own wants are so enormous, Canada is practically the only source of supply which she needs.

The latter is one of the more recent additions to the paper-making countries, but her importance is tremendous. Potentially, she is one of the greatest manufacturing countries; she has more water-power than any other country and a profusion of raw material. It is only recently that Canada's water powers have been estimated among the most valuable of her assets, chiefly owing to the discovery that the spruce, of which there is an inexhaustible supply, makes a better quality of paper than that of any other country. The wonderful network of lakes and rivers that veins the face of this country has now made it possible to use vast quantities of timber that must otherwise have been left to rot in its native woods. Figures are not available to express individual pulp-wood areas; but the visible aggregate of pulp-wood is estimated at 4,500 million tons.

In 1881 there were but 5 pulp-mills in Canada, with a total turnover of 50,000 tons; ten years later 25 mills, with an output of 110,000; and in 1903 39 mills, with an annual turnover of 400,000.

Her exports of pulp have increased, between 1888 and 1901, 2,000 per cent., as compared with Scandinavia's 7 per cent., but even now the export trade of the former is only doing one-half that of the latter. What is lacking for Canada is an adequate market, and if this should be enlarged the future of both paper and pulp is exceedingly hopeful. The acreage of forest land in Canada amounts to 512 millions, as compared with the

570 belonging to Europe. In the latter case, however, the greater part belongs to Russia; and this country is, for many reasons, not in a condition to use the riches of its forests. The obvious result should be that when the woodlands of Europe are at all depleted, Canada should become the source of supply for European markets.

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APPENDIX III

SHOWING THE AMOUNT OF PAPER MANUFACTURED IN ENGLAND, SCOTLAND, AND IRÊLAND, AND THE AMOUNT OF DUTY COLLECTED THEREON, 1800–1 TO 1855.

FIRST REPORT COMMISSIONERS INLAND REVENUE, 1857 (PAGES L. AND LI.).

ENGLAND

Year ended March 31st.	Paper.		Pasteboard.	Amt. of Duty.
	1st Class.	2nd Class.		
	1,000 lbs.	1,000 lbs.	Cwts.	£
1800–01			14,773	165,999
1801–02			15,564	227,417
1802–03			11,795	268,031
1803–04	23,369	6,835	14,695	349,638
1804–05	20,732	7,148	12,137	315,802
1805–06	23,355	9,015	13,488	361,644
1806–07	23,646	8,183	12,962	359,753
1807–08	24,613	7,847	13,217	368,267
1808–09	26,468	8,071	15,868	394,976
1809–10	25,463	8,275	18,436	384,935
1810–11	27,221	8,513	20,693	411,893
1811–12	27,160	9,134	20,512	415,406
1812–13	28,440	8,971	20,067	430,497
1813–14	27,446	8,592	20,099	415,428
1814–15	28,033	8,870	20,773	426,513
1815–16	29,862	9,461	23,206	455,710
1816–17	27,836	8,774	21,135	407,944
1817–18	27,215	8,552	24,109	450,727
1818–19	30,972	9,870	32,745	489,287
1819–20	29,997	9,583	32,532	457,595
1820–21	30,180	8,866	29,635	491,125
1821–22	31,989	10,192	32,235	503,223
1822–23	33,876	10,684	34,346	535,024

ENGLAND (*continued*)

Year ended March 31st.	1st Class.	2nd Class.	Pasteboard.	Amt. of Duty.
	1,000 lbs.	1,000 lbs.	Cwts.	£
1823–24	34,348	11,024	34,993	555,334
1824–25	36,307	12,335	37,640	593,641
1825–26	39,438	13,077	41,106	618,757
1826–27	32,615	9,507	31,145	501,565
1827–28	38,659	12,538	37,758	603,520
1828–29	41,386	13,364	42,541	648,351
1829–30	38,737	11,829	37,803	600,679
1830–31	39,521	12,908	40,743	619,824
1831–32	38,629	13,269	46,896	607,452
1832–33	40,492	13,457	35,095	629,938
1833–34	42,735	14,198	37,541	665,591
1834–35	44,714	14,211	39,039	691,941
1835–36	45,329	15,386	37,361	705,293
1836–37	53,301	13,688	27,347	640,304
		1,000 lbs.		
1837–38		71,921		449,508
1838–39		73,806		461,286
1839–40		76,987		481,170
1840–41		76,780		494,828
1841–42		76,293		500,671
1842–43		75,574		495,956
1843–44		79,137		519,339
1844–45		84,210		552,631
1845–46		95,066		623,869
1846–47		97,551		640,179
1847–48		92,851		609,336
1848–49		91,436		600,049
1849–50		98,917		649,141
1850–51		105,713		693,741
1851–52		112,197		736,292
1852–53		114,521		751,546
1853–54		132,481		869,404
1854–55		126,485		830,059
1855–56		128,905		845,938

SCOTLAND

Year ended March 31st.	Paper.			Pasteboard.	Duty.
	1st Class.	2nd Class.	3rd Class.		
	1,000 lbs.	1,000 lbs.	1,000 lbs.	Cwts.	£
1800–01	1,381	816	369	872	19,008
1801–02	1,873	860	426	1,150	24,573
1802–03	961	952	326	605	29,932
1803–04	2,694	243		847	36,077
1804–05	2,471	293		624	33,378
1805–06	2,760	323		917	37,488
1806–07	2,918	329		820	39,391
1807–08	2,887	345		1,035	39,329
1808–09	2,705	348		1,255	37,303
1809–10	2,838	344		1,541	39,245
1810–11	3,215	366		1,712	44,278
1811–12	3,179	364		2,219	44,346
1812–13	3,098	389		2,480	43,768
1813–14	3,055	401		2,240	43,044
1814–15	3,077	380		2,654	43,618
1815–16	3,329	462		2,559	47,205
1816–17	3,087	639		2,338	44,983
1817–18	3,395	607		2,922	49,299
1818–19	3,554	608		3,191	51,599
1819–20	3,398	657		3,080	48,849
1820–21	3,681	487		2,943	52,183
1821–22	4,120	620		3,155	58,798
1822–23	4,381	686		3,292	62,613
1823–24	4,706	756		3,194	67,076
1824–25	4,772	807		3,803	68,731
1825–26	5,514	880		5,490	80,219
1826–27	4,240	778		4,169	62,348
1827–28	5,488	965		5,302	80,526
1828–29	6,448	1,104		6,203	94,321
1829–30	6,084	1,078		7,585	90,916
1830–31	7,131	1,468		7,972	106,569
1831-32	6,775	1,579		7,029	101,901

SCOTLAND (*continued*)

Year ended March 31st.	Paper.		Pasteboard.	Duty.
	1st Class.	2nd Class.		
	1,000 lbs.	1,000 lbs.	Cwts.	£
1833–33	7,203	1,604	7,384	108,331
1833–34	7,318	1,770	8,583	111,560
1834–35	7,467	1,884	9,995	115,204
1835–36	8,627	2,046	11,986	132,202
1836–37	6,051	1,750	8,615	122,461
	1,000 lbs.			
1837–38	13,781			86,133
1838–39	16,106			100,660
1839–40	17,197			107,479
1840–41	16,866			108,675
1841–42	16,821			110,390
1842–43	17,066			111,993
1843–45	19,589			128,554
1844–45	20,727			136,024
1845–46	23,519			154,344
1846–47	24,016			157,603
1847–48	23,403			153,580
1848–49	24,801			162,755
1849–50	26,943			176,815
1850–51	28,600			187,688
1851–52	31,723			208,182
1852–53	32,575			213,773
1853–54	37,124			243,627
1854–55	36,858			241,879
1855–56	37,563			246,508

IRELAND

Year ended March 31st.	Paper.		Pasteboard.	Duty.
	1,000 lbs.		Cwts.	£
1800–01				10,634
1801–02	1,110			9,508
1802–03	1,024			10,910
1803–04	1,293			9,109
1804–05	1,239			10,098
1805–06	1,146			13,794
1806–07	1,403			14,711
1807–08	1,565			17,070
1808–09	1,224			16,550
1809–10	1,507			17,248
1810–11	897			17,006
1811–12	1,641			17,663
1812–13	1,640			17,060
1813–14	1,725			16,159
1814–15	1,352			14,799
1815–16	1,587			16,852
1816–17	1,849			19,773
1817–18	1,687			16,514
1818–19	1,576			16,883
1819–20	1,712			18,922
1820–21	1,404			16,017
	1st Class.	2nd Class.		
1821–22	1,178	391	196	17,846
1822–23	1,163	448	224	17,816
1823–24	1,126	458	193	16,930
1824–25	1,397	557	198	20,774
1825–26	2,649	769	583	38,565
1826–27	1,847	758	284	28,140
1827–28	1,685	705	199	25,690
1828–29	1,588	655	310	24,283
1829–30	1,501	578	322	22,741
1830–31	1,287	567	365	20,037

IRELAND (*continued*)

Year ended March 31st.	Paper.		Pasteboard.	Duty.
	1st Class.	2nd Class		
	1,000 lbs.	1,000 lbs.	Cwts.	£
1831–32	1,302	470	273	19,507
1832–33	1,709	470	496	24,834
1833–34	1,889	508	540	27,362
1834–35	1,874	458	368	26,677
1835–36	2,223	431	425	30,944
1836–37	2,434	468	284	28,013
	1,000 lbs.			
1837–38	3,248			20,301
1838–39	3,555			22,218
1839–40	3,463			21,641
1840–41	3,591			23,160
1841–42	3,991			26,194
1842–43	4,053			26,601
1843–44	4,723			30,995
1844–45	4,557			29,907
1845–46	5,662			37,158
1846–47	5,876			38,560
1847–48	5,712			37,482
1848–49	5,583			36,641
1849–50	6,273			41,164
1850–51	6,720			44,097
1851–52	6,984			45,830
1852–53	7,373			48,385
1853–54	8,028			52,686
1854–55	7,584			49,769
1855–56	7,443			48,844

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APPENDIX V

NUMBER OF MILLS IN THE UNITED KINGDOM

		England and Wales.		Scotland.		Ireland.		Total.
Years.		Number of Mills.		Number of Mills.		Number of Mills.		Number of Mills.
1838		416		49		60		525
1839		414		50		55		519
1840		362		48		52		462
1841	Av. 370	388	Av. 46	48	Av. 50	50	Av. 467	486
1842		375		48		49		472
1843		369		45		50		464
1844		363		46		52		461
1845		356		42		50		448
1846	Av. 349	359	Av. 48	46	Av. 43	47	Av. 441	452
1847		360		48		45		453
1848		351		49		44		444
1849		345		50		41		436
1850		328		48		39		415
1851	Av. 320	327	Av. 51	51	Av. 32	37	Av. 402	415
1852		312		48		34		394
1853		308		52		30		390
1854		325		51		29		405
1855		328		52		29		409
1856	Av. 306	314	Av. 52	52		28	Av. 384	394
1857		294		52		28		374
1858		307		52		27		386
1859		308		52		25		385
1860		306		54		25		385
1861								
1862								
1863								
1864								
1865		316		56		20		392
1866								
1867		275		57		21		353
1868		272		57		21		350
1869		276		56		21		353
1870		274		61				335

		England and Wales.		Scotland.		Ireland.		Total.
Years.		Number of Mills.		Number of Mills.		Number of Mills.		Number of Mills.
1871	Av. 283	273	Av. 61	60		20	Av. 358	353
1872		279		59		19		357
1873		288		60		18		366
1874		280		63				343
1875		294		64		15		373
1876	Av. 291	300	Av. 66	65		15	Av. 362	380
1877		293		66				359
1878		293		67		9		369
1879		287		67		10		364
1880		280		67		13		360
1881	Av. 271	281	Av. 64	67		14	Av. 340	362
1882		277		68		14		359
1883		277		65				342
1884		250		60				319
1885		262		60				322
1886	Av. 248	255	Av. 63	62			Av. 319	317
1887		255		62				317
1888		245		63		13		321
1889		243		64		13		320
1890		243		65		13		321
1891	Av. 234	237	Av. 61	62	Av. 12	14	Av. 307	313
1892		236		62		13		311
1893		238		61		14		313
1894		235		59		11		305
1895		226		59		10		295
1896	Av. 223	223	Av. 61	61	Av. 10	11	Av. 292	295
1897		223		61		9		293
1898		221		61		11		291
1899		225		60		9		294
1900		221		61		9		291
1901		221		61		8		290
1902		218		61		8		287
1903		213		61		8		282
1904		211		60		8		279

Figures from Paper Mill Directories.

APPENDIX VI

SHOWING THE NUMBER OF MACHINES IN ENGLAND AND WALES, SCOTLAND, IRELAND, AND UNITED KINGDOM FROM 1800–1904. ALSO THE NUMBER OF VATS IN THE UNITED KINGDOM

	ENGLAND AND WALES.		SCOTLAND.		IRELAND.	TOTALS.			
Years.		No. of Machines.		No. of Machines.	No. of Machines.		No. of Machines.		No. of Vats.
1800									
1801									
1802									
1803									
1804		3					3		762
1805		6					6		760
1806	Av. 14	10				Av. 14	10	Av. 742	750
1807		13					13		750
1808		14					14		740
1809		16					16		740
1810		17					17		730
1811	Av. 23	17				Av. 22	17	Av. 692	720
1812		20					20		710
1813		20					20		700
1814		27					27		670
1815		29					29		660
1816	Av. 31	30				Av. 30	30	Av. 616	650
1817		30					30		630
1818		31					31		610
1819		31					31		600
1820		32					32		590
1821	Av. 42	35	Av. 1	1		Av. 43	36	Av. 560	580
1822		37		1			38		570
1823		42		1			43		560
1824		45		2			47		550
1825		50		2			52		540
1826	Av. 61	55	Av. 4	3		Av. 65	58	Av. 508	530
1827		57		3			60		520
1828		62		4			66		510
1829		64		5			69		500
1830		67		5			72		480
1831	Av. 74	68	Av. 6	6		Av. 80	74	Av. 450	470
1832		70		6			76		460
1833		73		6			79		450
1834		76		7			83		440
1835		82		7			89		430

	England and Wales.		Scotland.		Ireland.	Totals.			
Years.		No. of Machines.		No. of Machines.	No. of Machines.		No. of Machines.		No. of Vats.
1836	Av. 120	90	Av. 8	7		Av. 127	97	Av. 400	420
1837		97		8			105		410
1838		109		8			117		400
1839		120		9			129		390
1840		182		9			191		380
1841	Av. 208	199	Av. 10	9		Av. 219	208	Av. 342	372
1842		200		10			210		360
1843		210		10			220		360
1844		215		10			225		320
1845		225		11			236		300
1846	Av. 240	230	Av. 14	12		Av. 254	242	Av. 244	280
1847		235		13			248		260
1848		240		13			253		250
1849		245		16	2		263		230
1850		250		17			267		200
1851	Av. 265	255	Av. 21	18		Av. 286	273	Av. 174	190
1852		260		19			279		180
1853		265		20	3		288		170
1854		270		22			292		170
1855		275		25			300		160
1856	Av. 290	280	Av. 34	28		Av. 324	308	Av. 144	160
1857		285		30			315		150
1858		290		35			325		140
1859		295		38			333		140
1860		300		40			340		130
1861	Av. 315	306	Av. 51	42		Av. 366	348	Av. 115	130
1862		310		45			355		120
1863		315		48			363		110
1864		320		55			375		110
1865		325		65			390		109
1866	Av. 335	328	Av. 68	65		Av. 402	393	Av. 108	109
1867		330		67			397		109
1868		333		68			401		108
1869		340		68			408		108
1870		344		69			413		108

	England and Wales.		Scotland.		Ireland.		Totals.			
Years.	No. of Machines.		No. of Machines.		No of Machines.		No. of Machines.		No. of Vats.	
1871	Av. 358	350	Av. 73	70			Av. 430	420	Av. 108	108
1872		354		72				426		108
1873		358		73				431		108
1874		360		74				434		108
1875		366		75				441		108
1876	Av. 381	370	Av. 77	76			Av. 465	446	Av. 107	108
1877		378		77				455		108
1878		381		78		11		470		107
1879		392		74		12		478		106
1880		383		81		12		476		"
1881	Av. 424	432	Av. 89	86	Av. 13	14	Av. 525	532	Av. 105	106
1882		427		88		12		527		106
1883		427		89		12		528		106
1884		423		90		13		526		105
1885		409		93		13		515		105
1886	Av. 415	417	Av. 107	101	Av. 15	14	Av. 536	532	Av. 105	105
1887		417		104		14		535		105
1888		424		108		15		547		105
1889		416		112		15		543		105
1890		401		111		15		527		105
1891	Av. 407	408	Av. 107	108	Av. 12	13	Av. 526	529	Av. 104	104
1892		407		109		11		527		104
1893		416		110		13		539		104
1894		408		105		11		524		104
1895		397		103		11		511		104
1896	Av. 411	403	Av. 109	108	Av. 11	11	Av. 530	522	Av. 104	104
1897		406		108		10		524		104
1898		409		109		11		529		104
1899		417		109		11		537		104
1900		418		110		11		539		104
1901		418		109		10		537		102
1902		417		109		10		536		
1903		417		110		11		538		
1904		414		109		9		532		
1905										

Compiled from various trade journals. Also information supplied by Mr. Bryan Donkin and other papermaking engineers and machinists.

APPENDIX VII

SHOWING THE AMOUNTS OF DUTY CHARGED ON VARIOUS ARTICLES OF PAPER MANUFACTURE

First Report Commissioners Inland Revenue, 1857

ENGLAND

RATES OF DUTY (EXCISE)

Years 1801 *and* 1802

Writing, Drawing, &c.	5d. per lb.
Coloured and Whited Brown	2d. ,,
Brown	1d. ,,
Unenumerated	5d. ,,
Pasteboard...	£1 1s. per cwt.
Glazed	6s. ,,

Years 1803–1815

1st Class	3d. per lb.
2nd ,, ...	1½d. ,,
Glazed	£1 1s. per cwt.

Years 1816–1820

(In addition to above rates.)

Pasteboard	made of 1st Class paper ...	£1 8s.	per cwt.
	,, of 2nd ,, ,, ...	14s.	

ENGLAND (*continued*)

Years 1821–1836

1st Class	3d.	per lb.
2nd „	1½d.	„
Glazed	£1 8s. £1 1s.	per cwt.
Pasteboard made of 1st Class paper	£1 8s.	„
Pasteboard „ of 2nd „ „	14s.	„

Years 1837–1839

1½d. per lb. on all kinds of paper.

Years 1840–1855

1½d. per lb. on all kinds of paper + 5 per cent. addition.

SCOTLAND

Rates of Duty (Excise)

Years 1801 *and* 1802

Writing, Drawing, Printing	5d.	per lb.
Colonial and Whited Brown	2d.	„
Brown	1d.	„
Unenumerated	5d.	„
Pasteboard	£1 1s.	per cwt.
Glazed	6s.	„

Years 1803–1815

1st Class	3d.	per lb.
2nd „	1½d.	„
Glazed	£1 1s.	per cwt.

Years 1816–1820

(In addition to above rates.)

Pasteboard of 1st Class paper	£1 8s.	per cwt.
„ „ 2nd „ „	14s.	„

SCOTLAND (*continued*)

Years 1821–1836

1st Class	3d. per lb.
2nd ,,	1½d. ,,
Glazed...	£1 8s. £1 1s. per cwt.
Pasteboard of 1st Class paper	£1 8s. per cwt.
,, of 2nd ,, ,,	14s. ,,

Years 1837–1839

1½d. per lb. on all kinds of papers.

Years 1840–1855

1½d. per lb. and 5 per cent. additional.

IRELAND

Rates of Duty

Years 1800–1804

1st Class 2½d. per lb. 2nd ,, 1d. ,,	or charge per engine per month	£20 16s. 8d.
3rd ,, ½d. ,,	ditto	£8 6s. 8d.
Glazed...		5s. per cwt.
Pasteboard		10s. ,,

Years 1805 and 1806

1st Class, 3d. per lb. 2nd ,, 2d. ,,	or charge per engine per month	£32 9s. 8d.
3rd ,, 1d. ,,	ditto	£16 13s. 4d.
Glazed		5s. per cwt.
Pasteboard...		£1 ,,

IRELAND (*continued*)

Years 1807–1815

1st Class	3d. per lb.	or per engine	£16 13s. 4d.
		,, vat ...	£12 10s. 0d.
2nd ,,	1d. per lb.	or per engine	£8 6s. 8d.
		,, vat ...	£8 6s. 8d.
Glazed ...			5s. per cwt.
Pasteboard			£1 ,,

Years 1815–1817

Same rates of duty { or charge per engine 10s. per cubic foot of its contents.

Years 1818–1824

Same rates of duty { or charge per engine 12s. 6d. per cubit foot of its contents.

Years 1825–1836

1st Class	3d. per lb.
2nd ,,	1½d. ,,
Glazed...	£1 1s. per cwt.
Millboard	£1 8s. ,,
Pasteboard, 1st Class	£1 8s. ,,
,, 2nd ,,	14s. ,,

Years 1837–1839

1½d. per lb. on all kinds of paper.

Years 1841–1855

1½d. per lb. on all kinds of paper and 5 per cent. additional.

APPENDIX VIII

Showing the Amount of Duty collected on Paper manufactured in England, Scotland and Ireland, 1800–1859

	England and Wales.		Scotland.		Ireland.		Total.	
Years.		Duty in £.		Duty in £.		Duty in £.		Gross Duty in £.
1800		165,999		19,008		10,634		195,641
1801	Av. 304,506	227,417	Av. 32,300	24,573	Av. 10,684	9,508	Av. 347,480	261,498
1802		268,031		29,932		10,910		308,873
1803		349,638		36,077		9,109		394,824
1804		315,802		33,378		10,098		359,278
1805		361,644		37,488		13,794		412,926
1806	Av. 383,965	359,753	Av. 39,309	39,391	Av. 16,519	14,711	Av. 440,389	413,855
1807		368,267		39,329		17,070		424,666
1808		394,976		37,303		16,570		448,829
1809		384,935		39,245		17,248		441,418
1810		411,893		44,278		17,006		473,177
1811	Av. 428,711	415,406	Av. 44,396	44,346	Av. 16,507	17,663	Av. 489,613	477,414
1812		430,497		43,768		17,060		491,325
1813		415,428		43,044		16,159		474,631
1814		426,513		43,618		14,799		484,930
1815		455,710		47,205		16,852		519,767
1816	Av. 459,332	407,944	Av. 49,781	44,983	Av. 17,622	19,773	Av. 526,340	472,700
1817		450,727		49,299		16,514		516,540
1818		489,287		51,599		16,883		557,769
1819		457,595		50,840		18,922		525,366
1820		491,120		52,183		16,017		559,325
1821	Av. 561,196	503,223	Av. 67,489	58,798	Av. 22,387	17,846	Av. 651,070	579,867
1822		535,024		62,613		17,816		615,453
1823		555,334		67,076		16,930		639,340
1824		593,641		68,731		20,774		683,146
1825		618,757		80,219		38,568		737,544
1826	Av. 594,788	501,565	Av. 86,736	62,348	Av. 24,178	28,140	Av. 706,039	592,053
1827		603,520		80,526		25,690		709,736
1828		648,351		94,321		24,283		766,955
1829		600,679		90,916		22,741		714,336
1830		619,824		106,569		20,037		747,114

	England and Wales.		Scotland.		Ireland.		Total.	
Years.		Duty.		Duty.		Duty.		Gross Duty.
1831	Av. 660,043	607,452	Av. 113,440	101,901	Av. 25,865	19,507	Av. 799,660	728,862
1832		629,938		108,331		24,834		763,104
1833		665,591		111,560		27,362		804,513
1834		691,941		115,204		26,677		833,822
1835		705,293		132,202		30,944		868,000
1836	Av. 507,419	640,304	Av. 105,082	122,461	Av. 23,067	28,013	Av. 634,497	795,483
1837		449,508		86,133		20,301		556,000
1838		461,286		100,660		22,218		584,000
1839		481,170		107,479		21,641		610,000
1840		494,828		108,675		23,160		627,000
1841	Av. 458,693	500,671	Av. 128,261	110,390	Av. 30,171	26,194	Av. 697,051	637,254
1842		495,956		111,993		26,601		635,000
1843		519,339		128,554		30,995		679,000
1844		552,631		136,024		29,907		719,000
1845		623,869		154,344		37,158		815,000
1846	Av. 638,489	640,179	Av. 163,688	157,603	Av. 39,580	38,560	Av. 841,939	836,000
1847		609,336		153,580		37,482		800,000
1848		600,049		162,755		36,641		799,000
1849		649,141		176,815		41,164		859,575
1850		693,741		187,688		44,097		915,121
1851	Av. 806,648	736,292	Av. 230,794	208,182	Av. 49,103	45,830	Av. 1,080,749	993,592
1852		751,546		213,773		48,385		1,000,630
1853		869,404		243,627		52,686		1,148,116
1854		830,059		241,879		49,769		1,167,407
1855		845,938		246,508		48,844		1,094,000
1856								1,232,000
1857								1,258,000
1858								1,266,000
1859								1,429,000
1860								

Figures from Reports of Commissioners of Inland Revenue.

APPENDIX IX

SHOWING THE PRODUCTIONS OF HAND-MADE AND MACHINE-MADE PAPER IN THE UNITED KINGDOM FROM 1800–1904

Years.	Hand Made.		Machine Made.		Total.	
		Tons.		Tons.		Tons.
1800		11,347		—		11,347
1801	Av. 15,165	13,335		—	Av. 15,278	13,335
1802		14,888		—		14,888
1803		16,150		—		16,150
1804		14,950		10		14,960
1805		16,502		557		17,059
1806	Av. 14,716	15,451	Av. 3,327	1,524	Av. 18,044	16,975
1807		14,605		2,741		17,346
1808		14,813		3,371		18,184
1809		14,435		4,210		18,645
1810		14,278		4,793		19,071
1811	Av. 14,689	14,723	Av. 5,378	4,942	Av. 20,067	19,655
1812		15,062		5,057		20,119
1813		14,612		4,906		19,518
1814		14,123		5,670		19,793
1815		14,925		6,318		21,243
1816	Av. 13,446	14,024	Av. 7,340	5,981	Av. 21,186	20,005
1817		13,891		5,968		19,859
1818		25,229		7,273		22,502
1819		13,412		8,608		22,020
1820		12,675		8,873		21,548
1821	Av. 12,954	12,757	Av. 13,250	10,763	Av. 26,204	23,520
1822		12,876		11,891		24,767
1823		12,720		12,620		25,340
1824		12,750		14,459		27,209
1825		13,670		16,518		30,188
1826	Av. 11,250	10,323	Av. 17,549	13,764	Av. 28,799	24,087
1827		12,295		16,672		28,967
1828		12,682		18,586		31,268
1829		11,573		17,412		28,985
1830		9,377		21,313		30,690
1831	Av. 10,440	9,674	Av. 22,283	20,226	Av. 32,724	29,900
1832		10,388		20,775		31,163
1833		10,429		22,448		32,877
1834		10,497		23,493		33,990
1835		11,215		24,476		35,691

Years.	Hand Made.		Machine Made.		Total.	
1836	Av. 10,368	11,026	Av. 60,612	25,444	Av. 40,981	36,470
1837		10,151		29,559		39,710
1838		10,588		31,138		41,726
1839		10,140		33,460		43,600
1840		9,937		33,463		43,400
1841	Av. 9,122	9,690	Av. 38,315	33,660	Av. 47,438	43,350
1842		9,314		33,856		43,170
1843		9,040		37,160		46,200
1844		8,695		40,305		49,000
1845		8,875		46,595		55,470
1846	Av. 6,624	7,991	Av. 50,967	49,009	Av. 57,587	57,000
1847		7,378		47,122		54,500
1848		6,800		47,690		54,490
1849		5,525		53,463		58,988
1850		5,426		57,535		62,961
1851	Av. 4,738	5,041	Av. 69,167	62,327	Av. 73,105	67,368
1152		4,790		64,170		68,960
1853		4,956		74,344		79,300
1854		4,742		74,658		79,400
1855		4,164		70,336		74,500
1856	Av. 3,888	4,230	Av. 86,607	79,570	Av. 90,492	83,800
1857		3,682		81,918		85,600
1858		3,765		82,235		86,000
1859		3,907		93,343		97,250
1860		3,839		95,971		99,810
1861	Av. 3,716	3,615	Av. 104,646	96,385	Av. 108,360	100,000
1862		3,933		104,867		108,800
1863		4,103		114,897		119,000
1864		3,619		103,381		107,000
1865		3,310		103,700		107,000
1866	Av. 3,356	3,695	Av. 115,043	119,305	Av. 118,400	123,000
1867		3,219		105,781		109,000
1868		3,603		119,397		123,000
1869		3,415		113,585		117,000
1870		2,850		117,150		120,000

Years.	Hand Made.		Machine Made.		Total.	
1871	Av. 3,622	4,660	Av. 142,429	155,400	Av. 145,840	160,000
1872		3,728		131,522		135,250
1873		3,243		129,357		131,600
1874		3,213		140,137		143,350
1875		3,268		155,732		159,000
1876	Av. 3,271	3,002	Av. 210,866	153,148	Av. 214,170	156,250
1877		3,005		171,935		175,000
1878		3,226		196,774		200,000
1879		3,571		246,429		250,000
1880		3,552		286,048		289,600
1881	Av. 3,332	3,850	Av. 330,905	304,150	Av. 334,238	308,000
1882		3,324		314,866		318,190
1883		2,617		329,883		332,500
1884		3,215		346,785		350,000
1885		3,658		358,842		362,500
1886	Av. 3,805	3,499	Av. 437,736	378,301	Av. 441,540	381,800
1887		3,399		399,901		403,300
1888		4,282		484,718		489,000
1889		4,016		456,984		461,000
1890		3,822		468,778		472,600
1891	Av. 3,866	3,443	Av. 497,319	470,857	Av. 501,186	474,300
1892		4,022		479,358		483,380
1893		3,770		480,480		484,250
1894		4,168		525,832		530,000
1895		3,930		530,070		534,000
1896	Av. 3,922	3,800	Av. 596,987	544,800	Av. 600,910	548,600
1897		4,129		592,871		597,000
1898		3,903		595,397		599,300
1899		3,894		604,106		608,000
1900		3,886		647,764		651,650
1901		3,875		691,625		695,500
1902		3,880		746,120		750,000
1903		3,898		769,652		773,550

Estimated from Appendix V. and VI.—Number of Vats, Machines and Mills. Appendix I.—Imports and Rags collected in this country.

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